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THE RELATIONSHIP OF LOCUS OF CONTROL AND FIELD-DEPENDENCE-INDEPENDENCE TO THE LEARNING OF EMG AND DIGIT TEMPERATURE CONTROL THROUGH BIOFEEDBACK TRAINING IN SUBJECTS WITH MIGRAINE HEADACHES

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE RELATIONSHIP OF LOCUS OF CONTROL AND FIELD-DEPENDENCE-INDEPENDENCE TO THE LEARNING OF EMG AND DIGIT TEMPERATURE CONTROL THROUGH BIOFEEDBACK TRAINING IN SUBJECTS WITH MIGRAINE HEADACHES submitted by PENNY CAROL FORD in partial fulfilment of the requirements for the degree of Master of Education.

DEDICATION

This thesis is dedicated to my mother and father whose love, support, and encouragement helped me reach this goal.

ABSTRACT

The primary purpose of this research study was to determine the relationship between two measures of individual differences and learned control of two physiological responses through biofeedback training.

Specifically the two measures of individual differences investigated in this study were locus of control and field-dependence-independence. Locus of control was measured by Rotter's I-E scale. Field-dependence-independence was measured by the Group Embedded Figures Test (GEFT). The two physiological responses investigated were frontalis muscle tension and digit temperature.

A sample of forty-eight migraine headache sufferers was used. Subjects were divided into two groups (internal and external) according to their scores on Rotter's I-E scale. Subjects were then regrouped and redivided into two groups (field independent and field dependent) according to their GEFT scores. Subjects from each group were then randomly assigned to one of two treatment conditions: EMG biofeedback or digit temperature biofeedback.

It was hypothesized that the internal as compared to the external group and the field independent as compared to the field dependent group would acquire control of their EMG and digit temperature responses more quickly (as measured by mean number of sessions taken to meet criterion), attain a greater decrease in their EMG levels during training, attain a greater increase in their digit temperature during the increase trials during training, attain a greater decrease in their digit temperature during the decrease trials during training, and reduce the frequency and intensity of their migraine

headaches from the pre-treatment to the post-treatment periods to a greater extent.

The results did not provide support for the expected differences between the internal and external groups or between the field independent and field dependent groups on any of the five variables investigated.

The research results suggest that further research is required to assess the relationship between locus of control and field-dependence-independence and learned control of EMG and digit temperature responses through biofeedback training.

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CHAPTER I

1. INTRODUCTION

Research has proven that human subjects can learn to control various physiological responses when given appropriate instructions and provided with biofeedback. Researchers have regularly observed 'between subject' variability in the extent of control attained. Recently researchers have turned to an examination of individual differences as independent variables. It would be desirable to determine the basis of these individual differences in biofeedback efficacy along some measurable dimension with the goal of predicting performance on a biofeedback task. This study suggests that individuals respond differently to tasks of physiological control and that these differences can be observed between groups identified by certain measures of individual differences.

The purpose of this study was to contribute to the research which has investigated the relationship between individual differences and performance on a biofeedback task. To date, research in this area has not been abundant and the results have been contradictory.

In the present research two measures of individual differences were investigated: locus of control and field-dependence-independence. The two measures of individual differences were investigated in relation to success in two types of biofeedback tasks: control of frontalis muscle tension and control of digit temperature. On the basis of their scores on Rotter's I-E scale subjects were divided into an internal and external group. Subjects were then regrouped and redivided into two groups, field independent and field dependent, on the basis of their scores on the Group Embedded Figures Test (GEFT). Subjects in each group were then randomly assigned to one of two treatment conditions: EMG

biofeedback or digit temperature biofeedback.

Previous research studies in this area have typically used university student samples. The present research used a clinically relevant sample consisting of migraine headache sufferers. In addition, the present research differed from most previous research in: the provision of adequate training time, the enhanced motivation of the subjects, and the provision of social reinforcement in addition to the biofeedback.

It was hypothesized that internal as compared to external subjects and field independent as compared to field dependent subjects would attain quicker control over their EMG and digit temperature responses, would attain a greater decrease in their EMG levels, would attain a greater increase in their digit temperature under increase instructions, would attain a greater decrease in their digit temperature under decrease instructions, and would reduce the frequency and intensity of their migraine headaches to a greater extent.

1.1 Rationale for the use of EMG and temperature biofeedback training in the treatment of migraine headaches

The two types of biofeedback used in the treatment of headaches are electromyograph (EMG) and temperature biofeedback. The treatment of migraine headaches typically includes some form of relaxation training in combination with the biofeedback training. The present study used a combination of either EMG biofeedback and progressive relaxation training or temperature biofeedback and autogenic relaxation training in the treatment of migraine headaches.

The cause of migraine headaches is unknown. However, migraine headaches are known to be related to changes in the vascular system.

The period just prior to the headache is characterized by intracranial arterial vasoconstriction which leads to intracranial and extracranial vasodilation during the headache phase (Yates, 1980). After the vasoconstrictive phase (of which stress has been implicated as a causative factor) the body attempts to restore circulatory homeostasis in the cranium. However, as a result of the depletion of serotonin, which regulates the normal tonus of the arteries, the arteries vasodilate and trigger the pain sensors of the smooth muscles, thereby causing the headache pain.

The use of temperature training biofeedback in the treatment of migraine headaches was discovered and developed by Sargent, Green, and Walters (1972, 1973). The decision to use the approach of hand warming was the result of a chance observation. A female subject, while attempting to increase the blood flow in her hands reported spontaneous recovery from a migraine headache. The disappearance of the headache coincided with a 10 degree fahrenheit rise in temperature in 2 minutes. The effect of hand warming is that of increasing peripheral vasodilation which is hypothesized to abort the vasoconstrictive phase immediately preceeding a migraine which in turn aborts the actual migraine headache phase.

EMG biofeedback training was initially used in the treatment of tension headaches. The use of EMG biofeedback training in the treatment of migraine headaches resulted from the finding that chronic high levels of tension in the head and neck muscles are common among migraine sufferers (Pozniak-Patewicz, 1976). Furthermore, Bakal and Kagomov (1977) presented evidence that migraine patients exhibit higher frontal EMG activity than muscle contraction headache patients and that

EMG biofeedback is equally effective for migraine and tension headache subjects. It has been suggested that in certain people migraine headaches may be produced indirectly due to the effects of high levels of muscle tension. A pattern of responding to stress via the vasomotor and skeletal musculature may eventually trigger the mechanisms which lead to the migraine headache (Carney, 1981). With EMG biofeedback an attempt is made to reduce muscle tension throughout the body and indirectly produce the peripheral vasodilation sought in temperature training.

The efficacy of EMG biofeedback procedures without the addition of relaxation training in the treatment of migraine headaches is unclear. Temperature training, however, has been found effective when used alone (Johnson & Turin, 1975; Turin & Johnson, 1976; Wickramasekera, 1973). The use of relaxation training in addition to the biofeedback training is thought to facilitate psychosomatic response control. In relaxation training the main goal is general decreased arousal with the subsequent enhancement of particular physiological changes. Alternatively, the primary goal in biofeedback training is control over a specific physiological response while a secondary outcome is general decreased arousal.

The important components of biofeedback treatment procedures for the reduction of migraine headaches have not yet been determined. Numerous studies have reported a therapeutic benefit in the treatment of migraine headaches by a combination of biofeedback and relaxation training. No studies have yet been reported, however, that unequivocally show the superiority of temperature biofeedback over EMG biofeedback or vice versa.

1.2 Overview

This first chapter provides a rationale for the present research, an overview of the processes that are used in this research, a rationale for the use of EMG and digit temperature biofeedback training for the treatment of migraine headaches, and an overview of what is contained in subsequent chapters.

The second chapter reviews the related theory and research of both the locus of control and field-dependence-independence constructs. The sections pertaining to each of these constructs contain: the theoretical framework for the development of the construct, a discussion of the evolution of the particular measurement and related measures, and a selective review of the research consisting of studies which have employed biofeedback and other related studies. The final section of this chapter contains the hypotheses.

Chapter three deals with the methodology of this research. This chapter contains an introduction, and a description of: the subjects, research design, instruments, apparatus and facilities, and procedures.

Chapter four presents the results of this research. The chapter contains: an introduction, discussion of how the groups were determined, the results of the analyses comparing pre-treatment EMG and digit temperature levels of the different groups, and a presentation of the results of the statistical analyses for each of the hypotheses.

Chapter five discusses the results of the present research. The chapter contains: an introduction, a summary of the results obtained, explanations for the negative results obtained, and the theoretical implications first for the results pertaining to the locus of control construct and then for the results pertaining to the field-dependence-

independence construct, practical implications of the present research, and finally, suggestions for future research.

CHAPTER II

2. REVIEW OF RELATED THEORY AND RESEARCH

2.1 Introduction

This chapter contains a review of the theory and research related to both the locus of control and field-dependence-independence constructs. The first section of each of the reviews deals with the theoretical framework of the construct. An examination of the theory underlying the construct aids in a more complete understanding of the formation and scope of the construct. The second section of each review deals with the evolution of the measurement of the construct. Each review concludes with a review of those studies which investigate the relationship between the construct and various types of biofeedback and also relevant studies which have not employed biofeedback.

2.2 Locus of control

2.2.1 The theoretical framework: Social learning theory

The concept of locus of control emerged from Rotter's theory of social learning. The major assumptions of social learning theory are:

1. "The unit of investigation for the study of personality is the interaction of the individual and his meaningful environment" (Rotter, 1954, p. 85). In order to deal accurately with behavior both personal determinants and environmental determinants must be considered.

2. The emphasis of the theory is on learned behavior. Unlearned biological determinants are considered less important than learned

attitudes, values and expectations.

3. Personality has unity. New experiences are influenced by old learnings and old learnings are changed by new experiences.

4. Social learning theory considers behavior to be determined by both situation-specific factors and broader more general dispositions.

5. Behavior is goal-directed and motivated. Positive and negative motivators can be identified by observing the direction of behavior.

6. "The occurrence of a behavior of a person is determined not only by the nature or importance of goals or reinforcements but also by the person's anticipation or expectancy that these goals will occur" (Rotter, 1954, p. 102). Behavior is determined by the degree to which people believe that their behavior will lead to goals and reinforcements. Expectancies for the outcomes of behaviors are learned and they depend upon past experience.

Social learning theory requires the analysis of four kinds of variables in order to make a prediction about an individual's behavior: behavior potential, expectancy, reinforcement value, and the psychological situation. Rotter suggests the following basic formula for the prediction of goal-directed behavior (1954, p. 105):

$$BP_{x,s_1,R_a} = f(E_{x,R_a s_1} \ \& \ RV_{a,\ s_1})$$

This formula states that "the potential for behavior x to occur in situation 1 in relation to reinforcement a is a function of the expectancy of the occurrence of reinforcement a following behavior x in situation 1 and the value of reinforcement a in situation 1" (Rotter, Chance, & Phares, 1972, p. 14). Behavior potential "refers

to the potentiality of any behavior's occurring in any given situation or situations as calculated in relation to any single reinforcement or set of reinforcements" (Rotter, 1954, p. 105). Expectancy is the "probability held by the individual that a particular reinforcement will occur as a function of a specific behavior on his part in a specific situation or situations" (Rotter, 1954, p. 107). In relatively novel situations generalized expectancies are more important in determining expectancy than specific expectancies based on prior experience in that situation. The value of a reinforcement is defined as "the degree of preference for any reinforcement to occur if the possibilities of their occurring were all equal" (Rotter, 1954, p. 107). And finally, the psychological situation is considered an extremely important determinant of behavior in social learning theory.

The formula stated above is limited in application because it deals only with the prediction of a specific behavior in relation to a single specific reinforcement. Therefore, Rotter suggests the following formula which may be used for more general prediction:

$$NP = f(FM \; \& \; NV)$$

This formula states that "the potentiality of occurrence of a set of behaviors that lead to the satisfaction of some need (need potential) is a function of the expectancies that these behaviors will lead to these reinforcements (freedom of movement) and the strength or value of these reinforcements (need value)" (Rotter, 1954, p. 110). Rotter suggests that a need has three essential components. The first of these is a set of behaviors directed toward the same goal. Need potential is the potential occurrence of these related behaviors. The second component is the set of expectancies that these related

behaviors will lead to goals that a person values. Freedom of movement is the average level of those expectancies. The third component of needs is the value attached to the goals themselves or the degree to which a person prefers one set of satisfaction to another set.

Generalized expectancies can be described in terms of a probability for success that has been generalized from past related situations. Generalized expectancies are similar to learning sets: situations are considered similar because the person sees them as presenting similar problems to be solved. One special and important type of generalized expectancy is referred to as internal versus external control of reinforcement. People are known to differ in their belief that what happens to them is dependent upon their own behaviors and attributes and is thus controllable by their actions (internal control) versus the belief that what happens to them is the result of luck, fate, chance, or powerful others (external control). People who believe or expect that they control their own fate will behave differently in many situations than those who expect that their own outcomes are controlled by other people or determined by luck. Locus of control constitutes a personality dimension that has been studied extensively and has proved useful for the prediction of a wide variety of behaviors.

2.2.2 The evolution of measurement of individual differences in locus of control

Phares (cited in Phares, 1976) made the first effort to develop a scale to measure individual differences in locus of control beliefs. He developed an instrument consisting of 13 skill items and 13 chance items presented in a Likert scale format. Phares' results suggested

that research into a scale to measure individual differences in locus of control beliefs or expectancies would be worthwhile. James (cited in Phares, 1976) followed Phares' early work by improving and revising Phares' scale. The development of these early scales followed from early experimental studies regarding the I-E variable. Phares and James "predicted that subjects achieving external scores on the scale would behave on an experimental task as if they were in a group receiving chance instructions while an internal group's performance would parallel that produced by skill instructions" (Phares, 1976, p. 39).

These early efforts were followed by more systematic and extensive scale development work by Rotter, Seeman and Liverant (1962). Rotter, et al. (1962) began by determining explicitly what it was they wanted to measure. Rotter et al. (1962) differentiated between ideal, theoretical, and operational definitions of the I-E construct. The ideal definition is the verbal description of the construct which is broad and general and contains all the surplus meaning attached to the construct. The theoretical definition states the antecedent condition and subsequent responses which are mediated by the I-E construct and the relationship of the I-E construct to other relevant constructs. Finally the operational definition refers to the scale or measure of I-E that is used. Part of the ideal definition used by Rotter and his colleagues is the following:

> When a reinforcement is perceived by the subject as following some action of his own but not being entirely contingent upon his action, then, in our culture, it is typically perceived as the result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him. When the

> event is interpreted in this way by an individual, we have labelled this a belief in external control. If the person perceives that the event is contingent upon his own behavior or his own relatively permanent characteristics, we have termed this a belief in internal control (Rotter, 1966, p. 1).

Rotter et al. (1962) began by developing an I-E scale that would contain items from several different areas: academic recognition, social recognition, general life philosophy, social-political events, love and affection, and dominance. The first scale contained 100 forced-choice items. One item in each pair dealt with an external belief and the other with an internal belief. After this scale was item and factor analyzed the scale was reduced to a 60-item version. However, problems with this subscale approach led to its being abandoned. Following the early attempt, Liverant, Rotter and Crowne refined the 60-item scale into a 23-item version that became known as the Rotter Internal-External Control Scale (Rotter I-E scale). Most of the research on individual differences in the control variable with adults has been based on the Rotter scale.

Since the development of the Rotter I-E scale over a dozen additional instruments have been developed to measure internality-externality. Four forms of I-E scales are available for use with children: the Nowicki-Strickland Locus of Control Scale (for grades to three to nine), the Stephens-Delys Reinforcement Contingency Interview - SDRCI (for ages four to ten), the Intellectual Achievement Responsibility Questionnaire - IARQ (relevant only to the academic situation, for grades three through twelve), and the Bialer-Cromwell Children's Locus of Control Scale (for retarded children). Short forms were created from the IARQ and the Nowicki-Strickland scales. Several scales are available for use with adults: a multidimensional I-E

scale developed by Gurin, Gurin, Lao and Beattie (1969), an abbreviated 11-item Rotter I-E scale developed by Valecha, James' I-E Locus of Control Scale, and Levenson's multidimensional I,C, and P scales (MacDonald, 1973).

2.2.3 Selective review of locus of control research

2.2.3.1 Introduction

In a biofeedback task the subject is asked to exert control over a physiological response. Conceptually, the individual variable locus of control seems related to the sorts of differences between subjects that might account for differential responsiveness to biofeedback. It seems reasonable that a person's beliefs about his own ability to influence events in general should extend to his ability to alter his own physiology. Scalese (1978) states that "advancements in the area of psychophysiology lead to the conclusion that the concepts of locus of control and environment are extended beneath a person's skin to include internal processes" (p. 2565). In addition, if it is assumed that internal subjects perceive feedback signals as contingent upon their own efforts while external subjects are unsure of the relationship between their efforts and the feedback they receive, it is reasonable to suggest that internal subjects relative to external subjects believe in their ability to influence the feedback signal and as a consequence become more involved in the task.

2.2.3.2 Biofeedback studies

Heart rate biofeedback studies

One of the earliest studies concerning locus of control and

biofeedback was Fotopoulos' (1970) study which investigated locus of control and the ability to increase heart rate. Fotopoulos divided 32 college students into external and internal locus of control groups according to their scores on Rotter's I-E scale. These groups were instructed to increase their heart rate under conditions of visual feedback and no feedback. In the feedback conditions there were reinforced and nonreinforced groups. Without feedback internal locus of control subjects produced greater heart rate increases than external locus of control subjects. Internal subjects also increased heart rate more than external subjects when given feedback without reinforcement. With feedback and reinforcement the analysis indicated no difference between internal and external subjects in ability to increase heart rate. The finding that internal subjects perform better than external subjects under conditions of no feedback and feedback without reinforcement supports the theoretical postulation that persons with an internal orientation would feel more independent and responsible for their own behavior and function optimally when depending upon themselves for results and not the environment. The finding that external subjects significantly increased their heart rate only when provided with reinforcement supports the postulation that external subjects do not rely upon themselves but mostly depend on the environment to determine their behavior.

Ray and Lamb (1974) replicated and extended Fotopoulos' findings by adding a decrease heart rate condition and controlling for mean baseline heart rate. Fifteen male undergraduates were divided into internal and external locus of control groups on the basis of their Rotter I-E scale scores. During one phase of the experiment subjects

were given four pairs of trials consisting of an increase and decrease condition and were provided with visual feedback. During the other two phases subjects did not receive feedback. Internal subjects performed best on the increase heart rate task and external subjects performed best on the decrease heart rate task. There was a nonsignificant difference between performance without feedback initially and the performance with the addition of feedback although there was a trend for better performance with feedback. The authors conclude that "the procedure of combining personality variables within a biofeedback paradigm appears rich for the researcher interested in psychosomatic medicine since he can both determine the parameters of a certain group's ability to control their physiology and the incidence of related psychosomatic disorders" (p. 182).

Ray (1974) replicated and extended Ray and Lamb's (1974) experiment by adding more structured self-report measures. Forty male undergraduates were divided into external and internal locus of control groups according to their Rotter I-E scale scores. Ray's (1974) results are consistent with those found by Ray and Lamb (1974) in that the internal subjects were better able to increase their heart rate from their baseline levels and external subjects were better able to decrease their heart rate. Ray also provided data based on self-report measures to suggest that internal and external subjects use different strategies to control heart rate. External subjects attend more to external events (i.e. look at objects in the room) while internal subjects attend more to internal events. In his conclusions Ray suggests that "an individual may possess a certain style for approaching a task physiologically in the same manner he demonstrates

a cognitive style" (p. 534).

Fotopoulos' (1970), Ray's (1974), and Ray and Lamb's (1974) studies involved only one session which provided very little training in heart rate control via biofeedback. Gatchel (1975) states that "as a result one does not know if locus of control significantly affects learning or merely differentially affects an individual's initial physiological response to a novel experimental task" (p. 424). Gatchel examines whether the influence of locus of control changes as efficient learning of the task occurs over training sessions. Gatchel selected 30 male undergraduates who received four 15 minute training sessions, two in speeding and two in slowing heart rate. At the conclusion of the last training session all subjects completed Rotter's scale. Those in the upper half of the distribution were designated as the external locus of control group while those in the lower half were designated as the internal locus of control group. Internals were better able to increase their heart rate than externals and externals were better able to decrease their heart rate only during the initial session. The association became nonsignificant during the second training session. Gatchel concludes that researchers should conduct a number of training sessions before drawing any conclusions as to the relationship between locus of control and learned control of heart rate.

Schneider, Sobol, Herrmann and Cousins (1977) selected 12 internal and 12 external subjects according to Rotter's I-E scale scores. Subjects received two sessions of bidirectional heart rate

control trials. Subjects were instructed to control their heart rate without feedback, with visual feedback, and then without feedback during each of the two blocks (increase and decrease) of trials per session. Internals relative to externals were better able to increase their heart rate and showed more improved performance when feedback was provided. The difference in performance of the two groups was greater during the second of the two sessions. Neither group was able to significantly lower their heart rate. The authors suggest that heart rate slowing may involve different psychophysiological processes than heart rate speeding, and/or heart rate slowing may have been perceived to be a task involving chance rather than skill, in which case no difference between groups would be expected in light of the locus of control literature.

Blankstein and Egner (1977) tested the hypothesis that internal as compared with external locus of control subjects would show greater self-control of heart rate slowing and speeding. Blankstein and Egner suggest that internal subjects "whose beliefs are related to a number of cognitive and competence behaviors relevant to mastery of the environment should be better able to both raise and lower heart rate with or without feedback of heart activity" (p. 293). Blankstein and Egner suggest that Ray's (1974) finding that externals are better than internals at decreasing heart rate may be a reflection of external subjects' failure to attend to the task and simultaneous attention to irrelevant cognitive cues. Ray's procedure is criticized on the grounds that lumination level and characteristics of the physical environment were not specified and may have provided distracting stimuli; the feedback procedure was relatively complex; and the

duration of training was inadequate. In Blankstein and Egner's study 38 male volunteers were administered Rotter's I-E scale, ranked on locus of control scores, and divided at the median into internal and external control groups. Subjects were instructed to control heart rate and received continuous visual feedback of cardiac rate during three series of trials followed by a 'no feedback' transfer series. During each series subjects attempted to raise heart rate on five trials and to lower it on five trials. Internal subjects were superior to external subjects at raising their heart rate during the first series and they improved consistently across subsequent series including the no-feedback series. Externals showed small increases across each series. No significant differences between the internal and external groups were noted for slowing although the trend is toward relatively better performance in the internal subjects. These results are inconsistent with earlier studies (Ray, 1974; Ray & Lamb, 1974) which showed that external subjects are better able to decrease heart rate than internal subjects. The data suggest that extensive training is required in order for differential slowing performance to develop whereas speeding differences emerge rapidly.

Heart rate biofeedback studies summary

Existing data relating performance on the biofeedback task of heart rate control and the locus of control variable are by no means clear. The findings of Blankstein and Egner (1977), Ray (1974), Ray and Lamb (1974) and Schneider et al. (1977) suggest that internal subjects are better at increasing heart rate with feedback. Fotopoulos (1971) found no difference between internal and external

subjects in the ability to increase heart rate with feedback. Ray (1974) and Ray and Lamb (1974) found that externals are better at decreasing heart rate with feedback. Gatchel (1975) initially found internal subjects to be better at increasing heart rate and external subjects to be better at decreasing heart rate but this association became nonsignificant when an additional training session was provided. Blankstein and Egner (1977) found no significant differences between internal and external subjects'ability to decrease heart rate with feedback.

Some problems exist with the above studies. The Ray and Lamb (1974) study had a small number of subjects (15). In the two studies which mention reinforcement, Ray and Lamb (1974) and Ray (1974), the reinforcement consisted solely of course credit. The absence of adequate reinforcement other than the feedback signal may result in a lack of motivation to succeed at the biofeedback task. Additionally, in all of the studies subjects received an inadequate amount of training time consisting of a maximum of two sessions or a total of 1 hour of training over four sessions.

Alpha biofeedback studies

A number of studies have investigated the relationship between locus of control and EEG alpha rhythm feedback control. Johnson and Meyer (1974) selected 24 female volunteers, administered the Nowicki-Strickland I-E scale and divided the subjects into an experimental and control group. Twelve experimental subjects received three 40 minute practice sessions in increasing EEG alpha rhythm. Alpha activity increased only in the experimental subjects. Subjects with an internal locus of control were better able to use feedback to

increase their alpha activity than external subjects. Johnson and Meyer suggest that their findings "extend the locus of control research from situations that deal with the external environment to situations that deal with the internal bodily environment. Previous research has indicated that internal subjects seek information and adopt behaviors that facilitate personal control over the environment. The present results suggest that a definition of environment should. . .include the internal processes and functioning" (p. 913).

Goesling, May, Lavond, Barnes, and Carreira (1974) also studied the relationship between locus of control and alpha enhancement through biofeedback. Fifteen externally oriented and fifteen internally oriented subjects were chosen from a group of undergraduates who had completed Rotter's I-E scale. The subjects received one 40 minute training session during which they were instructed to increase alpha production using auditory feedback. Internally oriented subjects were better able to increase the density of their alpha rhythm than were the externally oriented subjects. Externally oriented subjects also learned to increase their alpha density with the augmented sensory feedback but not as quickly, consistently, or as well.

Greer (1974) studied the relationship between locus of control and the autoregulation of the alpha rhythm. Subjects were divided into two groups composed of 16 internal and 16 external locus of control subjects based on their scores on Rotter's I-E scale. Subjects received three 8 minute feedback trials in which they were instructed to increase their alpha output. In addition there was a control group consisting of five internal and five external subjects

who did not receive feedback. Only those subjects who received an auditory feedback stimulus were able to increase their alpha. Subjects with an internal locus of control produced greater average overall percent-time alpha than their external counterparts. Subjects with an internal locus of control also demonstrated significantly greater ability to increase percent-time alpha over the three feedback trials in comparison to external subjects.

Dolecki (1975) investigated whether internal or external female students differed in the amount of time they could sustain their alpha rhythm above a criterion level. Fifteen students were assigned to each of four groups: internal-experimental; internal-control; external-experimental; external-control. Experimental subjects received auditory feedback which corresponded to alpha activity above a criterion level. Subjects received 12-2 minute periods of feedback over a 2 hour period. Dolecki found no significant percent time alpha differences between the internal and external experimental students. This study, therefore, fails to support previous findings that suggest that internally oriented subjects are better able to use feedback to increase their alpha activity than external subjects.

Brolund and Schallow (1976) also investigated the relationship between locus of control and alpha facilitation via biofeedback. Eighty male undergraduates were assigned to one of four treatment conditions: feedback; backup reinforcement; yoked control; or no feedback control. The subjects in each group were further divided into internals and externals of the basis of Rotter's I-E scale. All groups received six 4 minute trials of training. Subject's locus of control scores were not significantly related to any dependent measure in the

study which supports Dolecki's (1975) findings. In addition the results suggest that additional reinforcement enhances the effects of feedback alone.

Alpha biofeedback studies summary

Similar to data on heart rate control, data relating performance on the biofeedback task of increasing alpha EEG density and the locus of control variable are unclear. The finding of three studies, Goesling (1974), Greer (1974), and Johnson and Meyer (1974) indicate that internal subjects are better at increasing alpha rhythms with feedback than external subjects. Two studies, Brolund and Schallow (1976) and Dolecki (1975) found no difference between internal and external subjects in the ability to increase alpha with feedback.

In the Johnson and Meyer (1974) study subjects received three 40 minute sessions consisting of a total of 2 hours of feedback. In the other studies subjects were provided with only one session of training which is inadequate in terms of learning a biofeedback task. Reinforcement was nonexistant or minimal (class credit) in all but one study. Brolund and Schallow (1976) in studying the effects of feedback found that backup reinforcement (consisting of money or extra experimental credit) was clearly more effective in enhancing alpha than any other treatment condition. Reinforcement and motivation are important aspects of learning a biofeedback task.

A galvanic skin response (GSR) biofeedback study

Wagner, Bourgeois, Levenson, and Denton (1974) studied the relationship between locus of control and voluntary control of GSR. Thirty undergraduates received five 2 minute sessions during which

they were instructed to lower their GSR while provided with visual feedback. Subjects were administered Levenson's multidimensional locus of control scales. Scale scores of the 10 subjects who were best able to lower their GSR responses were compared with the scores of those 10 subjects who were least able to lower their GSR. Results indicate that those subjects who were more successful at using biofeedback had significantly higher personal control scale (I) scores than those who could not make use of the biofeedback. This study provides some support for the hypothesis that internal subjects are more proficient at using biofeedback than external subjects. One shortcoming of the Wagner et al. (1974) study is the inadequate training time provided.

EMG biofeedback studies

Phillips (1976) was one of the earliest experimenters to study the relationship between electromyograph responses and locus of control. Sixty-four female subjects received four sessions of EMG biofeedback which consisted of a total of 40 minutes of relaxation training. Findings indicate that locus of control is not related to responsiveness to biofeedback training. Phillips suggests a need for further study into the role of motivation and other factors contributing to maintenance of learned relaxation.

Herzog (1976) studied the relationship between locus of control and effectiveness of EMG frontalis training. This study differed from Phillips' (1976) study in the addition of a control group to determine if feedback is superior to bogus feedback and the use of the Adult Nowicki-Strickland I-E scale rather than Rotter's scale to divide 52 male students into external, mid, and internal locus of control groups.

Subjects in each group were randomly assigned to one of two experimental conditions. The experimental groups received one session of EMG training with auditory feedback. The control group subjects were yoked to experimental subjects. No significant differences were found between the three locus of control groups, however, the trend appeared to demonstrate that internal locus of control is related to increased biofeedback efficacy. The trend also indicated that feedback would have been superior to bogus feedback by the second training period. It was concluded that the 2 hour experimental period was too short to permit adequate training.

Gaston (1976) explored the locus of control construct as a variable for predicting differences in the ability to use EMG feedback to reduce tension. Sixty undergraduates were classified as either internal or external on the basis of their Rotter I-E scale scores. A variable frequency tone provided feedback. Internal subjects had achieved lower tension levels than external subjects at the end of training.

Reinking (1976) examined the impact of locus of control on acquisition of EMG control. One hundred and twenty subjects received 10-30 minute EMG relaxation training sessions. All subjects reduced their EMG levels across sessions, however, internal subjects lowered their EMG scores significantly more than did external subjects.

Freedman and Papsdorf (1976) assessed the effects of frontal EMG biofeedback on six insomniacs. Rotter's I-E scale was administered and the results used to differentiate internal and external subjects. Subjects received six 30 minute training sessions with auditory feedback. In addition subjects practiced relaxation daily at home for

20 minutes. Findings indicate no relationship between success in achieving relaxation and locus of control scores.

Stern and Barrenberg (1977) explored the relationship between biofeedback training in frontalis muscle relaxation and locus of control. Thirty-three undergraduates were divided into internal and external groups based on Mirel's (1970) factor analyzed personal control subscale of Rotter's scale. Subjects were randomly assigned to one of three conditions: biofeedback, false feedback, or no feedback. Training consisted of three 20 minute training sessions. Subjects receiving biofeedback had lower EMG levels than subjects in the other two conditions. Results indicate that EMG control was not affected by the subjects' locus of control.

Carlson (1977) also explored the relationship between locus of control and frontal EMG response training. Forty-eight undergraduates were divided into internal and external locus of control groups according to their score on a modified adult version of the Nowicki-Strickland locus of control scale. Subjects from each group were randomly assigned to one of two conditions: auditory feedback or control. The feedback group received eight 20 minute sessions of EMG training. During baseline sessions and within the control condition frontal EMG levels showed no consistent effects attributable to locus of control orientation. In the feedback condition internal subjects acquired lower frontal EMG levels than external subjects. Carlson states that the superior performance of the internal subjects in the frontalis muscle relaxation task "is consistent with Phares' characterization of internal persons as more active in their attempts to control, manipulate, or otherwise deal with their environment in an

effective way" (p. 269). Carlson cautions that it is advisable to conduct a number of training sessions when investigating relationships between locus of control and bodily self-regulation. He states that the relationship between the locus of control construct and self-regulation is clearly not a simple one. Carlson concludes that "the possibility that the locus of control construct might be a predictor of proficiency at using feedback to achieve striate muscle relaxation would have clinical significance beyond its theoretical importance. Preliminary testing of patients using a locus of control scale may facilitate the selection of feedback procedures or other related methods" (p. 260).

Modell (1977) assessed the relationship between locus of control and EMG frontalis biofeedback training. Three hundred and twelve college students completed Rotter's I-E scale. Subjects were categorized as internal or external, random selections were made and then subjects were randomly assigned to one of four groups: biofeedback, self-control, biofeedback-awareness, or control. Biofeedback subjects received one session of training during which they received auditory feedback. Findings did not indicate any consistent relationship between locus of control and reduction of muscle activity. Modell suggests that more research, particularly by the clinician, is necessary comparing cognitive modes of responding and the regulation of internal functions. The biofeedback awareness group achieved a greater level of relaxation than any other group suggesting that auditory reinforcement and a clear description of the meaning of the feedback facilitated lower levels of muscle activity.

Prager-Decker (1978) tested the relative efficacy of four

relaxation techniques in reducing tension levels of internal or external subjects who were experimentally exposed to a psycho-social stressor. Eighty-one male students were randomly assigned to one of the four relaxation training groups or to a control group based on their scores on Rotter's I-E scale. All training groups received seven 20 minute relaxation sessions. Three days later each subject was exposed to a stressor. Results indicated that external subjects trained with biofeedback reduced their resting EMG levels more and at a faster rate than internal subjects.

Holliday and Munz (1978) studied the relationship between locus of control and ability to reduce frontalis muscle tension. Six psychosomatic and seven nonpsychosomatic subjects were administered Rotter's I-E scale. All subjects received eight 1 hour EMG biofeedback sessions (two forearm and six frontalis) and practiced muscle relaxation daily at home. There was a significantly high correlation ($r=-.81$) between the Rotter pre-test score and percent reduction from baseline in frontalis EMG for the nonpsychosomatic group but there was a nonsignificant correlation for the psychosomatic group.

<u>EMG biofeedback studies summary</u>

As with the previously cited research concerning the locus of control construct and the control of physiology through biofeedback no definite conclusions can be drawn as to the relationship between locus of control and EMG feedback. Three studies, Carlson (1977), Gaston (1976), and Reinking (1976) found internal subjects better able to decrease muscle tension with the aid of EMG feedback than external subjects. Holliday and Munz (1978) found that internal nonpsychosomatic subjects were better able to decrease EMG muscle tension than external

subjects but there was no difference in performance between internal and external psychosomatic subjects. Herzog (1976) did not find a significant difference in the ability of internal and external subjects to decrease muscle tension although these differences very closely approached significance and appeared to demonstrate that internal locus of control is related to increased biofeedback efficacy. Freedman and Papsdorf (1976), Modell (1977), Phillips (1976), and Stern and Barrenberg (1977) found no difference between internal and external subjects' ability to decrease muscle tension. Prager-Decker (1978) found that external subjects achieved a greater reduction in EMG levels and at a faster rate than internal subjects.

Of the above studies Gaston (1976), Herzog (1976), Modell (1977), Phillips (1976) and Stern and Barrenberg (1977) provided inadequate training time, the maximum being a total of one hour of feedback (over three sessions). Reinforcement when mentioned consists of course credit suggesting a possible lack of involvement or motivation on the part of the subjects.

Temperature biofeedback studies

Roca (1976) studied the effects of I-E locus of control on the self-regulation of peripheral skin temperature. Fifty-six undergraduates were divided into internal and external locus of control groups according to their scores on Rotter's I-E scale. A control group contained 56 subjects. The experimental subjects were randomly assigned to one of four treatment conditions: feedback and monetary reinforcement, feedback alone, reinforcement alone, or no feedback or reinforcement. Subjects received one session consisting of 10 minutes of training during which subjects were instructed to increase

their finger temperature. Overall, internal subjects did not perform significantly better than external subjects. Internal subjects without feedback or reinforcement performed significantly better than external subjects without feedback or reinforcement. External subjects receiving feedback alone performed significantly better than external subjects not receiving feedback or reinforcement.

Larsen (1977) studied differences between internal and external subjects in increasing hand temperature. Subjects were divided into internal and external locus of control groups according to their scores on Rotter's I-E scale. Subjects were then randomly assigned to one of four conditions: biofeedback, biofeedback and social reinforcement, autogenic training, or control. Subjects received one initial practice session and one training session. Feedback consisted of a green light which turned on when skin temperature increased. Hypotheses were based on the idea that internal subjects' learning would be enhanced under conditions of little or no feedback while external subjects would perform best under conditions with the greatest amount of feedback. Findings indicated no differences in performance between internal and external subjects in any of the conditions.

Temperature biofeedback studies summary

Larsen (1977) found no significant differences between internal and external subjects in their ability to increase skin temperature via biofeedback. Larsen suggests several areas that future research needs to examine including: differences among autonomic functions in how people can be trained to control them; a person's belief in the method used to train him/her; the motivation of the person; and the amount of training needed to learn control over autonomic functions.

Roca (1976) states that his findings substantiate the theoretical point of view that internal subjects rely more upon themselves when behaving and less upon the aid of external sources and vice versa for external subjects.

The major short coming identifiable in the Roca and Larsen studies is the inadequate time provided for training. Biofeedback temperature training consisted of only one session in Larsen's study and one 10 minute trial in Roca's study.

2.2.3.3 Other related studies

In addition to the relationship between locus of control and biofeedback training the locus of control construct has been studied in relation to a number of other cognitive and competence behaviors that can be described as attempts to master the environment (Lefcourt, 1972). Previous research has shown that internal subjects seek information and adopt behaviors that facilitate personal control over their environment. In addition it has been demonstrated that expectancies affect attentive processes (Ducette & Wolk, 1973; Lefcourt & Wine, 1969), and it should be predicted that the locus of control construct will be salient in any task where perception and the use of environmental cues (internal and external) are important. Ducette and Wolk (1976) have suggested that internal subjects differ from external subjects motivationally as well as cognitively and these differences are most salient under demanding task conditions. Biofeedback tasks are demanding and internal subjects may differ from external subjects in terms of exertion of control and differing efficiency. Even if it is assumed that both internal and external subjects want to succeed on tasks that allow the demonstration of

personal ability and skill internal subjects have a relatively higher expectancy for achieving such valued goals and this expectancy is expressed in task relevant behavior. Thus internals are more aware of challenges inherent in certain tasks (Lefcourt, 1967), make more attempts at controlling or mastering their environment and are more cognitively active and perceptually alert (Lefcourt, 1972), and are more ready to search for necessary information (Lefcourt & Wine, 1969). Lefcourt (1972) observes that greater attention to all types of cues is found for internal subjects provided those cues are relevant and can be used to resolve uncertainty. Lefcourt has also suggested that individuals who maintain internal control expectancies have a greater reliance on inner promptings and standards of judgment than those who hold external expectancies. Thus it is reasonable to suggest that internals make more effective use of self-reinforcement to reward and punish their behavior in a biofeedback task. Phares (1973) characterizes the internal person as "more active in their attempts to control, manipulate, and otherwise deal with their environment in an effective way" (p. 9). Phares (1976) reviews the literature concerning the differences between internal and external subjects in control of the self. Control over one's behavior has been studied in relation to smoking and birth control. From the findings Phares suggests that "perhaps related to internal's feelings that they can control the environment is the feeling that they can control themselves" (p. 68).

2.3 Field-Dependence-Independence

2.3.1 Origins of the concept of field-dependence-independence

The concept of field-dependence-independence originated in

studies using various devices to determine which cues are more important in the perception of the upright - visual field cues or inner vestibular and kinesthetic cues. The devices used included: the rod and frame test (RFT), the body-adjustment test (BAT), and the rotating room test (RRT). In each of these an item (rod or body) is surrounded by a visual field (frame or room) and the question is to what extent perception of the item is determined by the surrounding field. The subject's score is the amount of tilt of rod or body, in degrees, when these items are reported to be straight. Subjects demonstrate individual consistency across the tests in the degree to which they rely on inner versus visual field cues. People can be graded on a continuum in terms of the degree to which they depend on the external visual field in their perception of the upright. People who rely more on internal cues are said to be field independent while people who rely more on the visual field cues are said to be field dependent (Witkin, Dyk, Faterson, Goodenough & Karp, 1962).

Subsequent work linked performance in perception of the upright tasks to other kinds of perceptual tasks. Witkin (1950) studied the relationship between measures of the perception of the upright in space and the ability to locate camouflaged figures. Witkin (1950) developed the Embedded Figures Test (EFT) in which the subject must overcome an embedding context by locating a previously seen simple figure within a complex figure designed to hide it. Witkin found that field independent subjects do better than field dependent subjects on the test. These studies suggest that field dependent people tend to accept perceptual fields as given while field independent people achieve a degree of autonomy from the field by a process

of cognitive restructuring. The field-dependence-independence dimension was thus redefined as degree of competence at perceptual disembedding.

A further advance in extending the scope of individual differences originally observed in perception of the upright came with the discovery that performance reflected more than perceptual functioning. It was demonstrated that competence at disembedding in perceptual tasks was associated with competence at disembedding in non-perceptual problem solving tasks. In addition it was found that the ability to disembed item from context in perceptual and intellectual activities is associated with the ability to restructure a field when a task requires it. The now greatly enlarged scope of individual differences in perception of the upright was conceived as an articulated versus global field approach dimension, and was designated a "cognitive style".

Subsequent research linked the individual differences described thus far to differences in a still wider array of areas, including areas such as controls and defenses, body concept, and the self. At this point the construct of differentiation was introduced to conceptualize the most comprehensive level of self-consistency. Stated briefly, differentiation is a structural property of an organismic system. To characterize a system as more differentiated implies, first of all, segregation of self from nonself signifying a boundary between an inner core and the outer world. Differentiation also implies segregation of psychological activities from each other, such as thinking from acting. A system that is more differentiated is also characterized by specialization of function at the neurophysiological level. It was assumed that the development of

differentiation is an organism-wide process and thus it was proposed that greater or less differentiation is likely to characterize an individual's functioning in diverse domains. In the 1971 model of differentiation (see Figure 1) differentiation was considered the highest order construct. Four second order constructs radiated from the first level: articulated cognitive functioning, an articulated body concept, a sense of separate identity, and the availability of structured controls for channeling impulse and the tendency to use specific defenses. Field-dependence-independence was viewed as one of the lowest order constructs (Witkin et al., 1971).

More recent research has led to changes in the 1971 model of differentiation (see Figure 2). As in the earlier model differentiation continues to be located at the apex. At the level immediately below the apex are three major indicators of differentiation: self-nonself segregation, segregation of psychological functions, and segregation of neurophysiological functions. The field-dependence-independence construct is located in the self-nonself indicator (Witkin et al., 1979). This is certainly not the stopping point in the development of the differentiation construct. Just before his death (July 8, 1979) Witkin wrote the following: "Though it has changed very much in its lifetime, field dependence theory is still very much in evolution" (p. ix, Witkin & Goodenough, 1981).

2.3.2 Evolution of measurement of field-dependence-independence

In place of the rather complex devices required for some of the early lab tests of field-dependence-independence there are now available simpler devices and a variety of standardized reliable measures. The simple and complex figures which make up the EFT are modifications

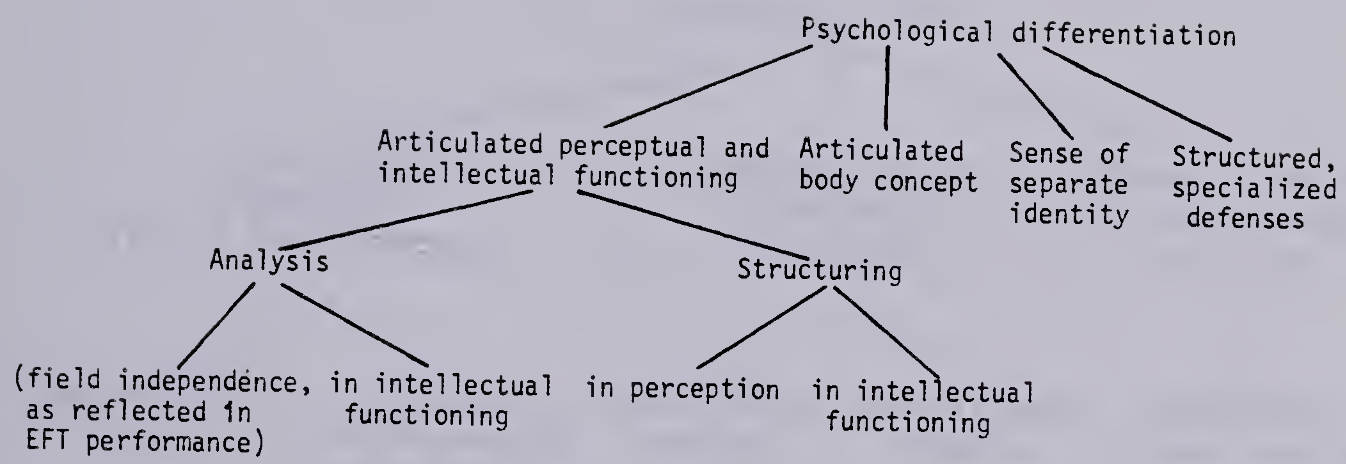

Figure 1

1971 Model of Differentiation

Note. From H. A. Witkin, P. K. Oltman, E. Raskin, and S. A. Karp, A Manual for the Embedded Figures Test, 1971, 14. Copyright 1971 by Consulting Psychologists Press, Inc.

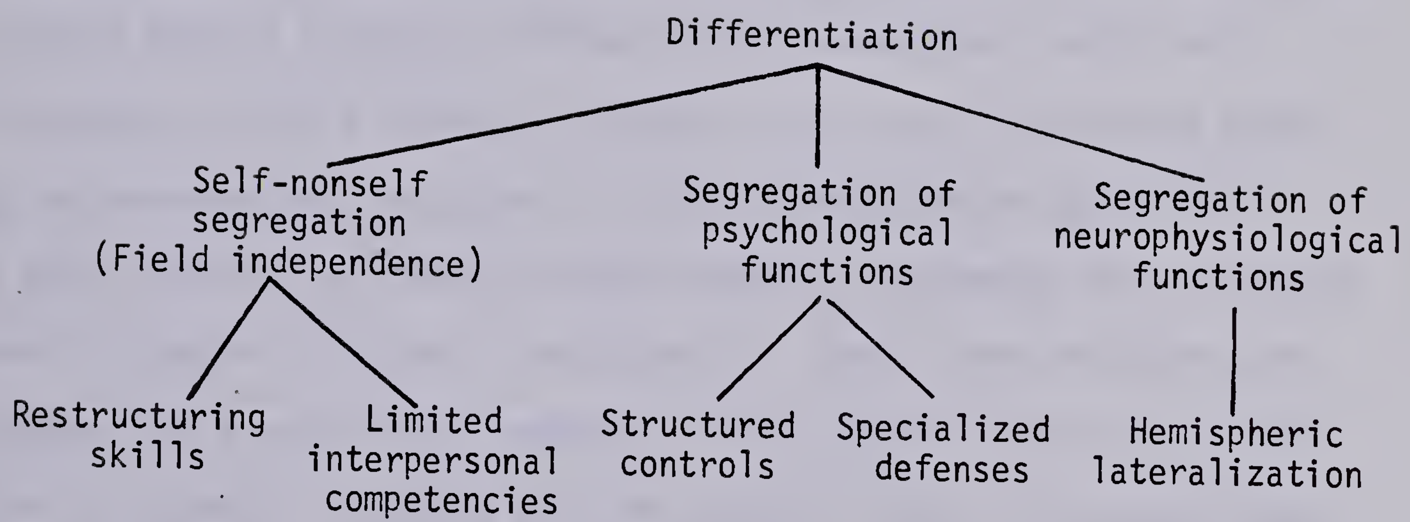

Figure 2

1979 Model of Differentiation

Note. From "Psychological Differentiation: Current Status" by H. A. Witkin, D. R. Goodenough and P. K. Oltman, Journal of Personality and Social Psychology, 1979, 37(7), 1138. Copyright 1979 by The American Psychological Association, Inc.

of figures used by Gottschaldt (cited in Witkin, Oltman, Raskin & Karp, 1971). Witkin was unable to obtain a sufficient number of difficult figures from Gottschaldt's material nor was he able to develop enough such figures using the line patterns used by Gottschaldt to embed the simple figures. Therefore, Witkin developed the additional method of obscuring the simple figures by coloring parts of the complex figure so as to emphasize certain subwholes. After extensive studies Witkin chose 24 complex and 8 simple figures. Two main criteria were used in selecting the figures: it was necessary to have figures graded in difficulty of disembedding; and it was necessary to have a variety of simple figures such that no one would be encountered too many times. In the administration of the EFT a card on which the complex figure appears is presented for 15 seconds and the subject is asked to describe it. Then a card containing the appropriate simple figure embedded in the complex figure is presented for 10 seconds. Following this the complex figure is presented again and the subject is instructed to trace the simple figure in it with a blunt stylus. The simple figure to be located is never the same in any two successive trials. The complex figure is presented first so that the subject will see the total complex pattern and be discouraged from searching for a single specific simple figure. The subject's score is the time taken to find the simple figure with a maximum of 5 minutes allowed. While searching for the simple figure the subject is permitted to reexamine the copy of it as often as needed for 10 second periods (this time is not included in the final score). However, at that time the complex figure is removed so that the complex and simple figures are never seen simultaneously.

Various forms of the EFT are available. A preschool EFT has been developed for use with children between the ages of three and five. A second children's test, the CEFT, has been developed for children aged five to nine. A group form of the EFT, the GEFT, has been developed by Witkin, et al. (1971) (and will be discussed later). There has also been developed a small portable table top model of the rod and frame device which can be easily transported and does not require a darkroom.

2.3.3 Selective review of field-dependence-independence research

2.3.3.1 Introduction

Conceptually, it seems likely that there would be a differential ability to process biofeedback based on the field-dependence-independence variable. The concept of field independence relates to an individual's ability to effect internalized frames of reference and orientation independent of environmental distractions, while the concept of field dependence relates to a person's ability to experience and process environmental stimuli in a global undifferentiated manner and to fail to maintain a separateness of his body from the surrounding field. If one considers successful self-regulation to depend upon a subject's awareness of internal states relative to physiological changes then learning to effect a change could be considered facilitated in people who have ready access to their internal states and feelings (i.e. field independent people). Very few studies have attempted to assess the relationship between the concept of field-dependence-independence and the ability to regulate one's physiological processes via augmented sensory feedback, and the findings thus far have not been encouraging.

2.3.3.2 Biofeedback studies

A heart rate biofeedback study

Berger (1978) studied the role of individual differences in the learning of heart rate deceleration and acceleration. Forty-five women were administered the EFT and the rod and frame test and then divided into field dependent and field independent groups. Subjects received one session consisting of sixteen 1 minute training trials. Subjects received auditory feedback, no feedback, or subjects were asked to maintain a tone that was under their control but they were not told that it was associated with their heart rate. Subjects in the feedback condition were better able to control their heart rate than subjects in the other two conditions. Findings indicated that field independent subjects exhibited less heart rate control than field dependent subjects.

Alpha biofeedback studies

Tutone (1974) studied the relationship between field-dependence-independence and voluntary control of EEG alpha rhythm. Twenty-one male undergraduates were randomly divided into two groups, one receiving alpha biofeedback training with auditory feedback for 1 hour and the other no feedback. Field-dependence-independence was assessed using Jackson's (1956) short form EFT. After training subjects receiving feedback demonstrated more alpha than controls. Field independent subjects produced significantly more alpha than field dependent subjects. Tutone suggests that his results indicate that "those individuals who have difficulty segregating environmental 'figures' from 'grounds' (field dependent people) also find it difficult to segregate relevant aspects of their experiential states"

(p. 342). Since the subjects were not selected on the basis of extreme scores and a significant correlation was obtained Tutone suggests that the field dependent variable should be given further consideration in biofeedback research.

Leib, Tyron, and Stroebel (1976) also studied the relationship between EFT performance and alpha enhancement. Twenty-two volunteer psychiatric inpatients were administered the EFT and RFT and divided into field independent, field dependent, and middle groups. Subjects' received 20-30 minute sessions of alpha biofeedback training. Analysis revealed that no between session learning occurred over the 20 sessions. Because no learning to control alpha occurred it was impossible to predict who profited more from alpha biofeedback, field dependent or field independent patients.

<u>A temperature biofeedback study</u>

Lovett (1977) studied the relationship between the ability to self-regulate skin temperature and perceptual style. Twenty subjects were assigned to two groups -- field independent or field dependent, on the basis of their scores on the GEFT. Subjects from each group were then randomly assigned to one of two milieu conditions: friendly or impersonal. All subjects received 14 days of biofeedback temperature training in which they were instructed to change the temperature of their dominant hand in a preselected direction. Ability to regulate skin temperature was not significantly related to GEFT performance.

<u>Biofeedback studies summary</u>

Tutone's (1974) findings provide some support for the hypothesis that independent subjects are better able to master a physiological

response (alpha rhythm) through the use of biofeedback. Leib et al. (1976) found no difference in the ability of field dependent and field independent subjects to control their alpha. Lovett (1977) found that GEFT performance did not distinguish ability to regulate skin temperature. Berger (1978) found that field dependent subjects were more successful at controlling their heart rate (especially in the increase heart rate condition) than field independent subjects.

In Tutone's (1974) and Berger's (1978) studies subjects were provided with an inadequate amount of training time. In addition, all of the above studies may be criticized for the fact that reinforcement was not provided (other than class credit), therefore, motivation to perform well may have been minimal.

2.3.3.3 Other related studies

A large body of research indicates that individual differences in EFT scores are related to behaviors in a wide variety of situations. Tyler (1965) states that "field dependent persons, those having greater difficulty with the EFT, showed up (in various studies) as more passive and anxious about control of body impulses, with lower self-esteem and less well differentiated body images than those who did well" (p. 212).

Gruen (1957) states that the personality features identified as correlating with field dependency are: "passivity in dealing with the environment, unfamiliarity and fear of one's own impulses and poor control over them, lack of self-esteem, and possession of a relatively primitive, undifferentiated body image. The personality features identified as correlating with field independence are: activity and independence in relation to the environment, closer

communication with and better control over one's own impulses, high self-esteem, and a differentiated mature body image" (p. 75).

Witkin and Oltman (1967) review recent research indicating that there are differences in physiological functioning between field dependent and field independent persons. One group of studies reviewed suggest that field dependent people are more likely to show excessive or maladaptive physiological discharge when confronted with unstructured or threatening situations. Cohen, Silverman, and Schmavonian (1962) studied reactions of subjects to sensory isolation and found that field dependent subjects were not as able to cope with the novel situation and reacted with more intense and prolonged physiological arousal. A novel environment containing an array of intricate biofeedback machinery may possibly constitute a threat and cause a similar reaction in field dependent subjects. Hustmyer and Karnes (1964) found more random spontaneous autonomic activity in field dependent subjects when they were requested to rest for 15 minutes suggesting an inability to adapt to the situation and the maintenance of an excessive amount of autonomic arousal. In relation to biofeedback training this suggests that field dependent subjects may be less able than field independent subjects to obtain low levels of EMG as a result of inappropriate and excessive arousal.

Goodenough (1976) reviewing the literature relating individual differences in field dependence to learning and memory suggests that field dependent subjects tend to use "spectator" approaches to learning whereas field independent subjects more often use "participant" approaches (p. 675). It is possible that field independent subjects would therefore be more successful in biofeedback training

because of their approach to and their involvement in the biofeedback task.

Witkin, Dyk, Faterson, Goodenough, and Karp (1974) found that the field independent person is more able to attend to a task and disregard distracting stimuli in the environment than a field dependent person. This ability is relevant to the present study in that although distracting stimuli were minimal some potential for distraction occurred particularly in regard to the noise of the data acquisition center and the presence of the experimenter. This would suggest that the field independent people would benefit more from biofeedback training because they are more task oriented and less distracted by external stimuli.

Witkin et al. (1971) suggest that field independent relative to field dependent subjects, in terms of body concept, have a definite sense of the boundaries of their body and of the inter-relations among its parts. If this could be extended to mean that field independent subjects have more body awareness than field dependent subjects then they could be expected to become more readily aware of the relationship between the biofeedback and the internal bodily process -- an awareness which must develop before regulation of bodily processes via biofeedback can occur.

2.4 Hypotheses

1. Subjects with an internal locus of control will acquire more rapid control over their EMG and digit temperature responses i.e. they will meet weaning criterion sooner than external subjects.

2. Subjects with an internal locus of control who receive EMG biofeedback training will attain a greater decrease in their EMG levels than subjects with an external locus of control who receive

EMG biofeedback training.

3. Subjects with an internal locus of control who receive digit temperature biofeedback training will attain a greater increase in their digit temperature than subjects with an external locus of control who receive digit temperature biofeedback training.

4. Subjects with an internal locus of control who receive digit temperature biofeedback training will attain a greater decrease in their digit temperature than subjects with an external locus of control who receive digit temperature biofeedback training.

5. Subjects with an internal locus of control will be more successful in reducing the frequency and intensity of their migraine headaches than subjects with an external locus of control.

6. Field independent subjects will acquire more rapid control over their EMG and digit temperature responses i.e. they will meet weaning criterion sooner than field dependent subjects.

7. Field independent subjects who receive EMG biofeedback training will attain a greater decrease in their EMG levels than field dependent subjects who receive EMG biofeedback training.

8. Field independent subjects who receive digit temperature biofeedback training will attain a greater increase in digit temperature than field dependent subjects who receive digit temperature biofeedback training.

9. Field independent subjects who reiceve digit temperature biofeedback training will attain a greater decrease in digit temperature than field dependent subjects who receive digit temperature biofeedback training.

10. Field independent subjects will be more successful in reducing

the frequency and intensity of their migraine headaches than field dependent subjects.

CHAPTER III

3. METHOD

3.1 Introduction

Several problems seem to exist in the studies concerning locus of control, field-dependence-independence and biofeedback training which limit their utility in the development of conclusions regarding the relationship between individual differences and learning a biofeedback task. The majority of previous studies have used undergraduates as subjects. The use of students as subjects limits the demonstration of whether or not the determination of individual differences will be clinically useful. The present study used a clinically relevant sample consisting of migraine headache sufferers. The motivation of student subjects in terms of learning a biofeedback task is questionable. In the present study it was explained that success in the biofeedback task would likely result in a decrease in the frequency and intensity of migraine headaches. The majority of previous studies have provided inadequate training time. It is possible in many cases that no learning of the biofeedback task occurred, rather subjects were merely responding physiologically to a new environment. The present study established a criterion level of achievement. All subjects received a minimum of four sessions. After four sessions if the subject had met criterion they began a weaning procedure. Subjects who did not meet weaning criterion by their fourth session continued training until they met criterion or until they had completed 12 sessions. In addition subjects were required to practice their skills for 30 minutes daily at home. All of the previous studies provided subjects with one mode of feedback. The present study provided subjects with a choice of

visual and/or auditory feedback. And finally in the majority of previous studies subjects were not provided with any reinforcement other than class credit. The present study provided subjects with social reinforcement. The present study has been designed to determine if individual differences and success at a biofeedback task show a consistent relationship by improving upon previous research in terms of: type of subject, subject's motivation, training time, feedback mode, and reinforcement.

3.2 Subjects

Subjects were selected from the respondents to a press release issued by the University Public Relations Department to all media in the Edmonton vicinity. The press release called for subjects for a biofeedback treatment program for migraine headache sufferers. All of the respondents were initially screened in a telephone interview and eligible respondents were invited to attend a general information session. The subjects were selected for inclusion in the study according to criteria set from the considerations discussed in Adams, Fueurstein and Fowler (1980) and Blanchard, Ahles, and Shaw (1979) (see Appendix A).

Each subject was required to obtain a physician's signature verifying that they were medically fit to participate in the study (see Appendix B). Each subject was also required to deposit $50.00 into a psychology department account which was used to help defray the cost of supplies. Following the decision to participate each subject and one of the three experimenters signed a written contract clearly stating the responsibilities of the subject and experimenters (see Appendix C).

3.3 Research design

Subjects who met the criteria of the telephone screening form were invited to attend one of the four general information sessions held during March and April. During the general information sessions subjects were administered the Rotter I-E scale and the GEFT. Those subjects who agreed to participate were divided at the median into an internal and external group according to their Rotter scale scores and then regrouped into field dependent and field independent groups according to their GEFT scores.

Subjects were then randomly assigned to one of two treatment conditions: a frontalis EMG feedback group or a digit temperature feedback group. Subjects received a minimum of four and a maximum of twelve treatment sessions beginning in either April or May.

During the three week baseline period previous to the beginning of treatment, all subjects were seen for a pre-treatment orientation session. During this session a psychophysiological stress profile was obtained. From this profile internal and external and field dependent and field independent subjects' baseline levels of EMG and temperature were obtained.

Approximately four weeks after treatment ended subjects returned for an individual follow-up session.

Headache intensity was evaluated over the three phases of the experiment including baseline, treatment, and follow-up.

Sixty-nine subjects began the treatment program. Two subjects had unscorable Rotter I-E scales and two subjects had unscorable GEFTS. Of the remaining subjects 13 did not complete treatment of had incomplete headache chart data. Of the remaining 54 subjects, 6 subjects were excluded from the data analysis in order to maintain an equal

number of subjects in each treatments-by-groups cell combination. Random selection procedures were used to exclude each of the subjects from the required cells leaving a total number of 48 subjects. The treatments by groups arrangements may be illustrated as follows:

GROUPS	TREATMENTS	
	EMG	TEMPERATURE
Internal	12	12
External	12	12
	EMG	TEMPERATURE
Field Independent	12	12
Field Dependent	12	12

There were 43 female subjects and 5 male subjects in both groups. Subjects ranged in age from 20 to 59 years. The median age in the internal-external group was 39.5. The median age in the field-dependent-independent group was 38.

3.4 Instruments

3.4.1 Rotter's I-E Scale

The Rotter's I-E scale consists of 29 question pairs using a forced choice format. Six of the question pairs are filler items included to disguise the nature of the test. Internal statements are paired with external statements (see Appendix D). The scale is self-administered and can be completed in about 15 minutes. One point is given for each external statement selected. Scores range from 0 (most internal) to 23 (most external).

Normative data are provided by Rotter (1966). Means and standard deviations of I-E scores for samples of several populations range from

5.48 to 10.00 and 2.78 to 4.20 respectively. MacDonald (1973) describing the work of Owens on an N of 4,433 reported the following overall means, male mean = 8.2 (S.D. = 4.0); females, mean = 8.5 (S.D. = 3.9); combined, mean = 8.3 (S.D. = 3.9) (p.228).

Rotter (1966) reported that two factor analyses had been completed, one by himself and the other by Franklin (cited in Rotter, 1966). Both analyses revealed one general factor which accounted for much of the total scale variance (53 percent in Franklin's analysis) and several additional factors which accounted for little variance and involved only two or three items each. More recent factor analyses (Cherlin & Bourque, 1974; Gurin, Gurin, Lao & Beattie, 1969; and Mirels, 1970) have shown the I-E scale to be multidimensional. Gurin et al. (1969) analyzing the responses of black students found that the I-E scale items loaded primarily on two factors which Gurin et al. (1969) labelled personal control and control ideology. The personal control items are phrased in the first person. The control ideology items are all third person statements concerning the control which people in general have over situations. Mirels (1970) proposes a different two factor structure. Mirels' first factor structure contains both first and third person I-E items while his second factor includes four of the five items which deal with controlling governments or the course of world affairs. Mirels' first factor combines the personal control and control ideology dimensions which Gurin et al. differentiated and suggests a belief concerning felt mastery over the course of one's life. The second factor is a belief concerning the extent to which the individual citizen is capable of having an impact on political institutions. Guttentag, MacDonald and Tseng, and Minton (cited in

MacDonald, 1973) also confirm the multidimensionality of Rotter's scale. These studies support the findings of Gurin et al. (1969) of a personal control and a control ideology factor. Levenson (cited in MacDonald, 1973) developed three new scales using items from Rotter's scale as well as original items. Levenson developed three scales of eight items each using a Likert format. The I scale measures the extent to which a person believes he has control over his life; the P scale is concerned with powerful others; and the C scale deals with chance. Cherlin and Bourque (1974) studied the dimensionality of the I-E scale in two samples and found a two-factor structure similar to that found by Mirels (1970). Cherlin and Bourque's first factor referred to as general control reflects the individual's expectancy of the extent to which his or her own actions as well as the actions of most others determine the course of life events. The second factor referred to as political control includes all control over politics and world affairs. Phares (1976) provides a comprehensive review of the multidimensionality issue of Rotter's I-E scale. Phares states "at the present time there is evidence for the existence of separate factors but there is much less evidence that demonstrates their predictive utility. Repeated demonstrations of the multidimensionality factor character of the I-E scale are not useful unless evidence can be adduced that these factors generate empirically separate predictions" (p. 48).

The Rotter I-E scale has been administered to numerous samples (Joe, 1971; Lefcourt, 1966, 1972; and Rotter, 1966). The scale has been used with adolescents and older subjects. No upper or lower age limits have been established.

It is difficult to summarize the findings related to sex differences on the I-E scale. Many studies do not report separate means for males and females. Numerous studies have not found sex differences in I-E scores. Rotter (1966) found sex differences to be minimal. Feather (1967) found relatively high external control scores among young female undergraduates as compared to males. Joe (1971) summarizing research on the I-E control construct concludes that sex differences appear to influence locus of control beliefs. Phares (1978) notes that early research on sex differences did not support the existence of such differences but that recent findings suggest small differences in the direction of externality in women.

Rotter (1966) reports internal consistency coefficients ranging from .65 to .79 using Spearman-Brown and Kuder-Richardson formulas. Cherlin and Bourque (1974) present reliability estimates ranging from .71 to .81.

For two subgroups of Rotter's 1966 sample test-retest reliability coefficients were obtained. For a sample of 60 college students a value of .72 was obtained after one month (for males, $r = .60$; for females, $r = .83$). After two months, an r of .55 was obtained for 117 college students (for males, $r = .49$; for females, $r = .61$). Rotter suggests that the lower reliabilities for the two month period may be due to the fact that the first test was administered to a group and the second test was administered individually. Hersch and Scheibe (1967) obtained test-retest reliability coefficients between .43 and .84 over a two month period with college students. An r value of .72 was obtained from 18 college students over a period of approximately a year.

Cardi, Ladwig and Strickland (cited in Rotter, 1966) using samples of male prisoners found correlations with intelligence ranging from .03 to -.22. Rotter (1966) concluded that correlations between intellectual measures and I-E scale scores are negligible or at best low. Hersch and Schiebe's (1967) data tend to corroborate this conclusion. They reported correlations from -.07 to -.17 for three different measures of intellectual ability.

Rotter (1966) reviewing the relationship between I-E and a measure of maladjustment, the Rotter Incomplete Sentences Blank, suggests that the relationship is perhaps curvilinear, perhaps complex, or perhaps nil.

Rotter (1966) reports that correlations with the Marlowe Crowne Social Desirability Scale obtained in a number of college student samples range from -.07 to -.35. Altrocci, Palmer, Helman, and Davis (1968), Feather (1967), and Hjelle (1971) found higher coefficients ranging from -.20 to -.42. Berzins, Ross and Cohen (1971) and Cone (1971) have found correlations between the I-E scale and Edward's Social Desirability Scales to range between -.23 and -.70.

The Rotter I-E scale is the most widely used test in the locus of control literature. Although it has undergone recent methodological criticism regarding lack of unidimensionality and social desirability response bias it continues to be the most popular I-E scale. Those who defend the scale argue that factors beyond the first factor account for little of the total scale variance or that such factors contain too few items to be useful as reliable subscales. In addition, most of the correlations between Rotter's scale and measures of social desirability response bias are low (MacDonald, 1973).

3.4.2 The Group Embedded Figures Test (GEFT)

The GEFT was developed by Phillip K. Oltman, Evelyn Raskin, and Herman A. Witkin. The GEFT is an adaptation of the original individually administered Embedded Figures Test (EFT) which makes group testing possible. The GEFT is modelled closely after the EFT with regards to mode of presentation and format. The GEFT contains 18 complex figures 17 of which were taken from the EFT. Within each complex figure is embedded a simple form which the subject must trace. Light shading of sections of the complex figures in the GEFT corresponding to those sections which are colored in the EFT emphasize the large organized Gestalten serving to embed the simple forms. As in the EFT the subject is prevented from seeing simultaneously the simple form and the complex form containing it. This is accomplished by having the simple forms on the back cover of the GEFT booklet and the complex figures on the booklet pages. The subject may refer back to the simple forms as often as they wish. The GEFT booklet contains three sections: the first section contains seven very simple items and is primarily for practice; the second and third sections each contain nine more difficult items. The test is timed. Subjects are given 2 minutes to complete the first section and 5 minutes to complete each of the other two sections. The score is the total number of simple forms correctly traced in the second and third sections combined.

Witkin et al. (1971) report norms based on a sample of 397 college students. The finding that men perform significantly better than women is consistent with the sex differences usually obtained with the EFT.

Witkin et al. (1971) report that the correlation between the second and third sections (i.e. parallel forms with identical time limits) using the Spearman-Brown formula produced an r of .82 for both males (N = 80) and females (N = 97). These reliability estimates are comparable to those of the EFT.

Witkin et al. (1971) assess the validity of the GEFT several ways. Correlations between the GEFT and EFT are r = -.82 for male college students (N = 73) and r = -.63 for female college students (N = 68). The correlation between the GEFT and a second measure of psychological differentiation, the portable rod and frame test are r = -.39 for male undergraduates (N = 55) and r = -.34 for female undergraduates (N = 68). Correlations of the GEFT with the EFT or PRFT should be negative because the tests are scored in reverse fashion. A third measure of psychological differentiation is the degree of articulation of the body concept as assessed by a scale (ABC) applied to human figure drawings. Correlations of the GEFT and ABC were r = .71 for male undergraduates (N = 55) and r = .55 for female undergraduates (N = 68). These correlations are comparable to those typically reported for the EFT.

3.5 Apparatus and Facilities

All biofeedback sessions were conducted in a 10 by 17 foot room. Dim lighting was provided by two 100 watt light bulbs in shaded table lamps. Subjects were seated in a comfortable chair facing a table containing the biofeedback equipment. The data acquisition equipment was set up apart from the subjects in the same room. The experimenter remained in the room during the sessions.

EMG levels were obtained from two standard silver-silver chloride electrodes placed one inch above each eyebrow and spaced four inches apart on the subject's forehead. One reference electrode was located in the center of the forehead. Subjects were scrubbed with alcohol before the application of the electrodes. Redux electrode cream was used to increase the contact of the electrode with the skin. Electrode impedence values were maintained below 10,000 ohms as recommended by the manufacturer. The electrodes were connected to an Autogenic Systems Incorporated 1700 electromyograph. The auditory and digital feedback levels of the EMG were generated using a one second response averaging mode. A 100-200 Hz frequency bandpass was used as recommended by the manufacturer for general muscle relaxation training. Biofeedback consisted of the visual display of EMG levels in microvolts on the volt meter and auditory feedback through a set of Koss stereo headphones which consisted of a series of clicks which corresponded to the level of frontalis muscle tension -- the higher the tension the faster the click rate.

Digit temperature readings were obtained using a research grade thermister attached with tape to the middle phalange of the middle finger of the nondominant hand (Surwit, Shapiro & Feld, 1976). The thermister was connected to either an Autogenic Systems Incorporated HT-2 or 2000b feedback thermometer. Digit temperature feedback consisted of the visual display of temperature levels in fahrenheit degrees on the fahrenheit scale and auditory feedback from a set of Koss stereo headphones consisting of a tone which corresponded to temperature changes -- as the temperature increased the tone dropped in pitch.

The feedback myograph and thermometer were connected to optically isolated A/D converters which in turn were connected to an Autogenic Systems Incorporated 5600 data acquisition center and printer assembly. This assembly was calibrated to provide a microvolt/second integrated voltage value. The average level of response over the final 10 seconds of each minute was recorded by the printer unit during treatment sessions.

3.6 Procedure

3.6.1 General information session

During the general information session subjects were given further information regarding the study. The medical form, treatment contract and headache monitoring forms were distributed and explained. The Rotter I-E scale and the GEFT were administered. Those subjects who agreed to participate made an appointment for a pre-treatment session and paid the $50.00 fee.

3.6.2 Pre-treatment orientation session

The psychophysiological stress profile was obtained using a modified version of the general guidelines described by Stoyva (1979) (see Appendix E). First the subject was instructed to relax with his or her eyes open for 5 minutes while EMG and temperature levels were being monitored. This initial 5 minute period allowed the subject to adapt to the unfamiliar environment and gave the experimenter time to adjust equipment when necessary. After the 5 minute period the subject was instructed to close his or her eyes and to continue relaxation for 15 minutes. After 15 minutes a 3 minute stress period was conducted during which the subject was instructed to serially subtract 7 from 1,000 as

fast and accurately as possible until told to stop. The subject was told that the experimenter would ask him or her what number they had reached at the end of the period. This task was performed silently and with the eyes closed. Finally a 5 minute recovery period was conducted during which the subject was instructed to keep his or her eyes closed and relax. A cassette tape provided quiet relaxing music during the adaptation and relaxation periods. Feedback was not provided during the stress profile session.

3.6.3 Treatment

Subjects recorded daily headache intensity and medication consumption during the three phases of baseline, treatment and follow-up using a grid rating scale developed by Budzynski, Stoyva, Adler and Mullaney (1973) (see Appendix F). The subjects were required to rate headache activity for each waking hour on a scale of 0 to 5 where: "0" = no headache; "1" = low level headache which enters awareness only at times when attention is devoted to it; "2" = awareness of a headache most of the time but it can be ignored at times; "3" = painful headache, but one is still able to continue at a job; "4" = severe headache which makes concentration difficult but one can perform undemanding tasks; "5" = intense incapacitating headache. The subjects were given headache monitoring forms which consisted of seven daily grids and an explanation of the severity scale. The forms were collected weekly as they were completed.

The three experimenters were graduate students in educational phychology with experience in both biofeedback training and counselling. Experimenters were assigned randomly to subjects throughout the entire study.

Subjects were scheduled in pairs for between four to twelve 45 minute sessions of either unidirectional EMG feedback training or bi-directional digit temperature feedback training at a frequency of two sessions per week. At the beginning of the first, fourth, and eighth sessions subjects were instructed to read a description of the rationale for the study which included the stages of biofeedback guided relaxation and some strategies as to how to achieve a "passive attitude" (see Appendices G and H). The experimenters provided coaching (review of instructions, verbal reinforcement, and support) as required.

The treatment sessions lasted approximately 45 minutes. Each session, after the subjects were disengaged from the biofeedback equipment: they were asked to complete a state anxiety form; they were asked to write down the strategies they had used to aid them in the biofeedback task; they were shown the printer tape of their results and provided with verbal reinforcement for their progress; medication consumption was discussed; and subjects had the opportunity to ask questions or discuss concerns related to the study.

3.6.3.1 EMG feedback training procedure

The subjects were first instructed to sit quietly for 5 minutes while EMG and temperature levels were being monitored. After 5 minutes baseline levels were recorded while the subjects continued to sit quietly for 2 minutes. After 2 minutes the subjects were instructed to decrease their muscle tension. Feedback was not provided during these initial three periods of treatment. After 2 minutes the subjects received three consecutive 5 minute periods of feedback (each followed by 1 minute of rest) with instructions to decrease their muscle tension.

Subjects were instructed to keep their eyes open during the entire treatment session (see Appendix I).

3.6.3.2 EMG feedback weaning procedure

Criterion to begin the weaning procedure was set at two consecutive 5 minute periods of EMG levels below 1.5 microvolts. Once criterion was met the subject began a weaning procedure in order to learn to relax without the aid of external feedback. The EMG weaning procedure was the same as the treatment procedure for the first three periods: a 5 minute adaptation period, a 2 minute baseline period, and a 2 minute period during which subjects were instructed to decrease their muscle tension. After the 2 minute "decrease" period subjects were given four consecutive 5 minute periods, the first and third with feedback and the second and fourth without feedback. Each 5 minute period was followed by 1 minute of rest. Subjects were instructed to decrease their muscle tension. If the subjects were able to obtain EMG levels of below 1.5 microvolts during the four consecutive periods they were finished training. If the subjects were unsuccessful they continued the weaning procedure until they were successful or until they had completed 12 sessions.

3.6.3.3 Digit temperature feedback training procedure

The digit temperature feedback procedure began with an initial adaptation period of 5 minutes followed by a 2 minute baseline period. Following the 2 minute baseline period subjects were instructed to increase their temperature. Subjects did not receive feedback during these first three periods. After 2 minutes the subjects had a 5 minute period of feedback with instructions to decrease their temperature

if temperature was 90 degrees fahrenheit or above or instructions to increase their temperature if their temperature was below 90 degrees. After 5 minutes the subjects were given a second 5 minute period with instructions to move the response in the opposite direction or to continue to increase their temperature if it was below 90 degrees. After 5 minutes subjects received one final 5 minute period of feedback with the same instructions as the second period (see Appendix J).

3.6.3.4 Digit temperature feedback weaning procedure

Criterion for beginning the weaning procedure was set at three consecutive 5 minute periods of alternately increasing and decreasing digit temperature 2 degrees. The temperature weaning procedure was the same as the treatment procedure for the first three periods: a 5 minute adaptation period, a 2 minute baseline period, and a 2 minute period during which subjects were asked to increase their temperature. After the 2 minute increase period subjects were given two 5 minute periods with feedback during which they were instructed to alternately increase or decrease their digit temperature. If subjects were successful at obtaining changes in the correct direction of 2 degrees or more they were given two 5 minute periods without feedback with the same instructions as the previous two periods. If subjects were successful at obtaining changes of 2 degrees or more they were finished training. If subjects were not successful they continued with the weaning procedure until they were successful or until they had completed 12 sessions.

3.6.4 Home practice

In addition to twice weekly training sessions in the lab subjects

were required to practice at home for one half hour daily. Subjects practiced the skills which they learned in the lab. In order to aid in this practice subjects were given an audio cassette tape. The EMG training group received an autosuggestive relaxation tape based on Jacobsonian relaxation techniques recorded by Dr. George Fitzsimmons. The temperature training group received an autogenic tape consisting of autogenic phrases (Green & Green, 1979, p. 159) also recorded by Dr. George Fitzsimmons. Both tapes required the subject to utilize the strategies they had found useful in the lab to help them relax. The subjects were also instructed to use their strategies at any time during the day when they felt a headache starting, or were tense or overstressed.

The temperature training group were given Biotic Bands II (from Biofeedback and Stress Management Publishing, Seattle, U.S.A.) and instructed to monitor and record finger temperature while they listened to the relaxation tape. The temperature scale of the band was attached to the palmer surface of the middle phalange of the middle finger of the non-dominant hand. Finger temperature was recorded after the band had been on the finger for 1 minute and again at the end of the tape (approximately 30 minutes later) (see Appendix K).

3.6.5 <u>Follow-up session</u>

Approximately four weeks after their final session subjects received a follow-up session. During this session subjects followed the same procedure as during the pre-treatment session.

CHAPTER IV

4. RESULTS

4.1 Introduction

Two different groupings of subjects were made. Subjects were divided into two groups (internal and external) of 24 subjects each according to their scores on Rotter's I-E scale and then regrouped and redivided into two groups (field independent and field dependent) of 24 subjects each according to their scores on the GEFT. Subjects in each group were then randomly assigned to one of two treatment conditions: EMG biofeedback or digit temperature biofeedback.

An initial analysis was conducted on pre-treatment EMG and digit temperature levels to test for group differences.

A series of two- and three-way Analyses of Variance were used to determine if significant differences between the groups existed in terms of five different variables: mean number of sessions taken to meet criterion, decreases in EMG levels, increases in digit temperature, decreases in digit temperature, and reduction in migraine headache frequency and intensity.

The present chapter describes the results of this research.

4.2 Group determination

A median split procedure was used to divide the subjects into an internal group (N=24) and an external group (N=24) according to their scores on Rotter's I-E scale. Scores for the internal group ranged from 2 to 9 with a mean of 6.63. Scores for the external group ranged from 9 to 18 with a mean of 11.79. The overall mean (N=48) was 9.21 with a standard deviation of 3.27.

A median split procedure was also used to divide the subjects in-

to a field independent group (N=24) and a field dependent group (N=24) according to their scores on the GEFT. Scores for the field independent group ranged from 8 to 17 with a mean of 12.25. Scores for the field dependent group ranged from 1 to 7 with a mean of 4.71. The overall mean (N=48) was 8.48 with a standard deviation of 4.69.

4.3 Pre-treatment EMG and digit temperature levels

The 15 readings obtained from the last 5 minutes of the 15 minute relaxation period of the pre-treatment session were averaged for every subject. A mean pre-treatment EMG level was then obtained for the EMG biofeedback groups and a mean pre-treatment digit temperature level was obtained for the digit temperature biofeedback groups. The data was then analyzed using t-tests to test for significance of the difference in mean pre-treatment levels between internal and external subjects and field independent and field dependent subjects. The results of the t-tests for EMG levels are given in Table 1 and for digit temperature levels in Table 2. There were no significant differences between internal and external subjects or between field independent and field dependent subjects with regard to pre-treatment EMG or digit temperature levels.

4.4 Hypotheses

Hypothesis 1

It was hypothesized that subjects with an internal locus of control would acquire control over their EMG and digit temperature responses at a faster rate i.e. they would meet weaning criterion sooner than external locus of control subjects. Criterion data were subjected to a two (group) by two (treatment) Analysis of Variance.

The group means and standard deviations are listed in Table 3.

Table 1

T Values for Pre-treatment EMG Levels

Group	Mean	T Value	Degrees of Freedom	Probability
Internal	1.69	-0.97	13	0.35
External	2.26			
Field Independent	1.37	-2.08	14	0.06
Field Dependent	2.52			

Table 2

T Values for Pre-treatment Temperature Levels

Group	Mean	T Value	Degrees of Freedom	Probability
Internal	93.04	0.95	22	0.35
External	90.93			
Field Independent	92.39	-0.42	22	0.68
Field Dependent	93.18			

Table 3

Mean Number of Sessions to Criterion for Internal and External Subjects (N=48)

Group		Treatment	
		EMG	Temperature
Internal	Mean	6.58	10.83
	S.D.	2.61	2.89
External	Mean	7.50	11.17
	S.D.	3.63	2.79

A summary of the Analysis of Variance appears in Table 4.

The Analysis of Variance did not reveal a significant group by treatment interaction. This suggests that there was no significant difference between internal and external subjects with regard to the mean number of sessions taken to meet criterion. The Analysis of Variance indicated a significant treatment effect for the criterion variable: $F(1,44) = 20.82$, $p < .001$. The significant treatment effect indicated that subjects who received EMG biofeedback met criterion sooner than subjects who received digit temperature biofeedback.

The results do not provide support for Hypothesis 1. Internal subjects did not meet criterion sooner than external subjects.

Hypothesis 2

It was hypothesized that subjects with an internal locus of control who received EMG biofeedback training would attain a greater decrease in EMG levels than subjects with an external locus of control who received EMG biofeedback training.

The 15 EMG readings obtained during the three 5 minute practice periods per session were averaged for each subject's first two and last two sessions. If the subject met criterion during treatment, the session at which they met criterion was considered their last session. The weaning procedure (which was introduced after subjects met criterion) differed from the treatment procedure and so the data from the weaning procedure sessions were not included in the analysis.

EMG treatment data were subjected to a two (group) by two (session) Analysis of Variance with repeated measures. The group means are listed in Table 5 and portrayed graphically in Figure 3. A summary of the Analysis of Variance appears in Table 6.

Table 4

A Two (Group) by Two (Treatment) ANOVA Summary Table

for the Criterion Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	4.69	1	4.69	0.52
B (Treatment)	188.02	1	188.02	20.82**
AB	1.02	1	1.02	0.11
Within	397.25	44	9.03	

** significant at the .001 level

Table 5

Mean EMG Levels for the First Two Sessions Combined and the Last Two Sessions Combined for Internal and External Subjects (N=24)

Group		Session	
		First Two	Last Two
Internal	Mean	1.63	1.20
	S.D.	0.48	0.28
External	Mean	1.87	1.27
	S.D.	0.76	0.38

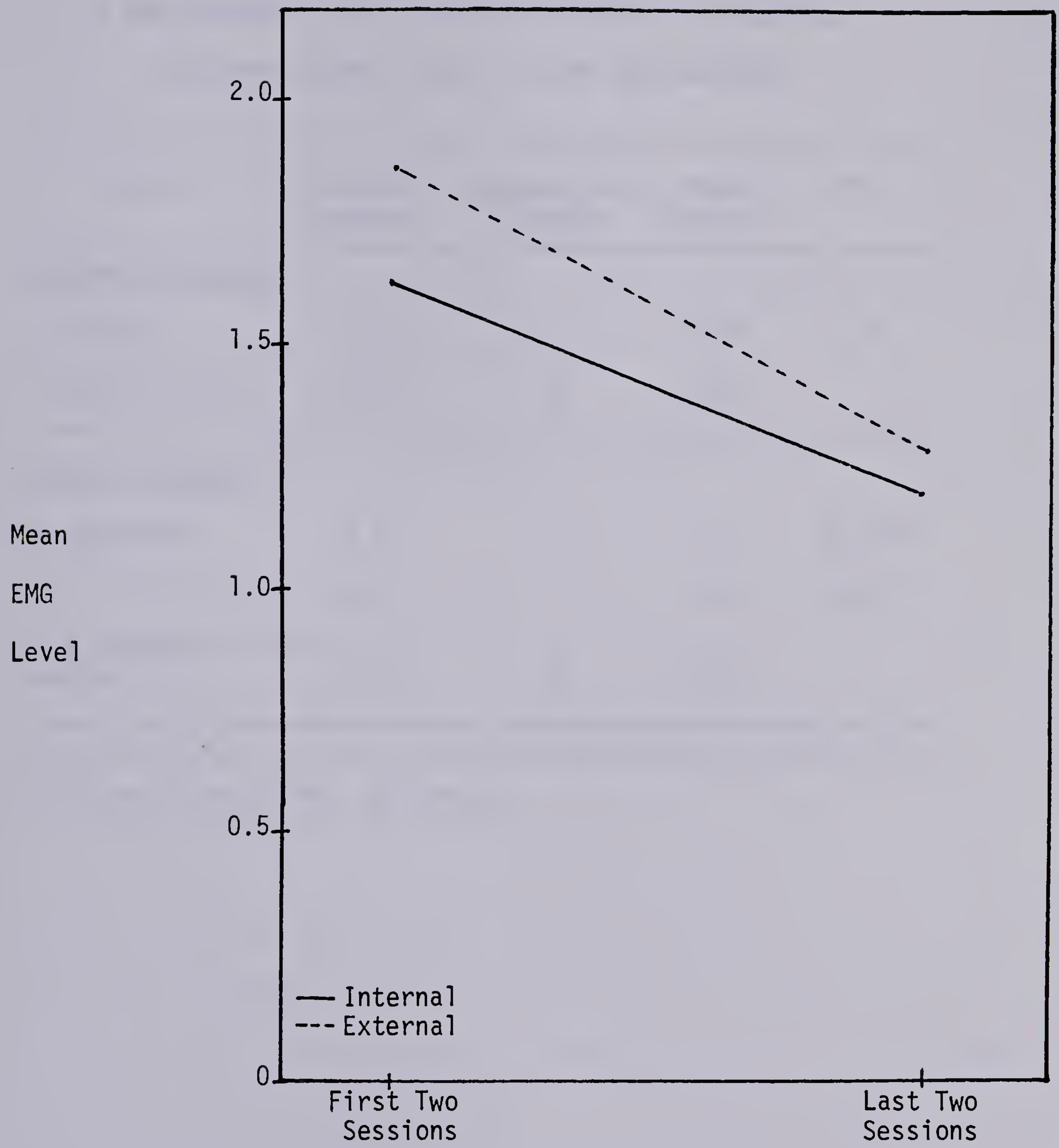

Figure 3

Mean EMG Levels for First Two Sessions Combined and Last Two Sessions Combined for Internal and External Subjects

Table 6

A Two (Group) by Two (Treatment) ANOVA with Repeated Measures Summary Table for the EMG Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	0.29	1	0.29	0.76
Subjects within	8.24	22	0.37	
Within Subjects				
B (Session)	3.17	1	3.17	22.36**
AB	0.09	1	0.09	0.65
B x Subjects within	3.12	22	0.14	

** significant at the .001 level

The Analysis of Variance did not reveal a significant group by session interaction effect. This suggests that there was no significant difference between internal and external subjects with regard to the mean reduction in their EMG levels from the first two to the last two sessions. The Analysis of Variance indicated a significant session effect: $F(1,22) = 22.36$, $p = .001$. The significant session effect indicated that both groups obtained a significant reduction in EMG levels from the first two to the last two sessions.

The results do not provide support for Hypothesis 2. Internal subjects did not attain a greater decrease in EMG levels than external subjects.

Hypothesis 3

It was hypothesized that subjects with an internal locus of control who received digit temperature biofeedback training would attain a greater increase in digit temperature than subjects with an external locus of control who received digit temperature biofeedback training.

The increase in digit temperature was calculated for each 5 minute practice period during which the subjects had been instructed to increase their digit temperature. A mean digit temperature increase was then obtained for the first two sessions combined and the last two sessions combined. An overall mean increase for the two periods (first and last) was then obtained for the internal group and for the external group.

The digit temperature increase data was then subjected to a two (group) by two (period) Analysis of Variance with repeated measures. The group increase means are listed in Table 7 and portrayed graphically in Figure 4. A summary of the Analysis of Variance appears in Table 8.

The Analysis of Variance did not reveal a significant group by ses-

Table 7

Mean Increase in Digit Temperature for the First Two Sessions Combined and the Last Two Sessions Combined for Internal and External Subjects (N=24)

Group		Session	
		First Two	Last Two
Internal	Mean	0.88	1.37
	S.D.	0.74	0.95
External	Mean	0.69	1.37
	S.D.	0.71	0.91

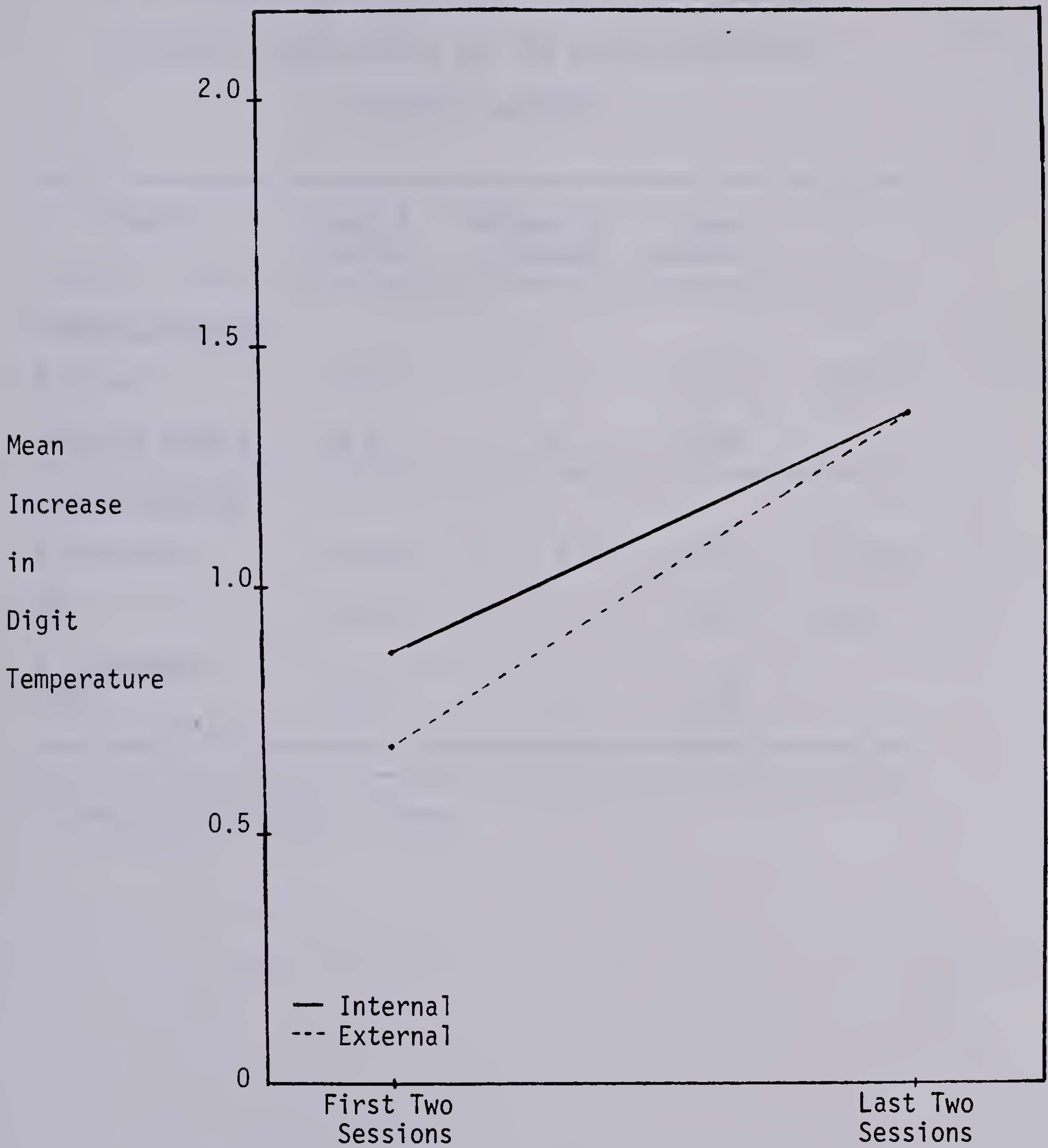

Figure 4

Mean Increase in Digit Temperature for First Two Sessions Combined and Last Two Sessions Combined for Internal and External Subjects

Table 8

A Two (Group) by Two (Period) ANOVA with Repeated Measures Summary Table for the Digit Temperature Increase Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	0.12	1	0.12	0.14
Subjects within	18.63	22	0.85	
Within Subjects				
B (Session)	4.15	1	4.15	7.55*
AB	0.12	1	0.12	0.21
B x Subjects within	12.11	22	0.55	

* significant at the .05 level

sion interaction effect. This suggests that there was no significant difference between internal and external subjects with regard to the mean increase in their digit temperature from the first two to the last two sessions. The Analysis of Variance indicated a significant session effect: $F(1,22) = 7.55$, $p < .05$. The significant session effect indicated that both groups obtained a significant increase in digit temperature from the first two to the last two sessions.

The results do not support Hypothesis 3. Internal subjects did not attain a greater increase in digit temperature than external subjects.

Hypothesis 4

It was hypothesized that subjects with an internal locus of control who received digit temperature biofeedback training would attain a greater decrease in digit temperature than subjects with an external locus of control who received digit temperature biofeedback training.

The decrease in digit temperature was calculated for each 5 minute practice period during which the subject had been instructed to decrease their digit temperature. A mean digit temperature decrease was then obtained for the first two sessions combined and the last two sessions combined. An overall mean decrease for the two periods (first and last) was then obtained for the internal group and for the external group.

The digit temperature decrease data was then subjected to a two (group) by two (period) Analysis of Variance with repeated measures. The group decrease means are listed in Table 9 and portrayed graphically in Figure 5. A summary of the Analysis of Variance appears in Table 10.

The Analysis of Variance did not reveal a significant group by session interaction effect. This suggests that there was no significant

Table 9

Mean Decrease in Digit Temperature for the First Two Sessions Combined and the Last Two Sessions Combined for Internal and External Subjects (N=24)

Group		Session	
		First Two	Last Two
Internal	Mean	0.65	1.37
	S.D.	0.46	0.66
External	Mean	1.00	1.38
	S.D.	0.80	0.93

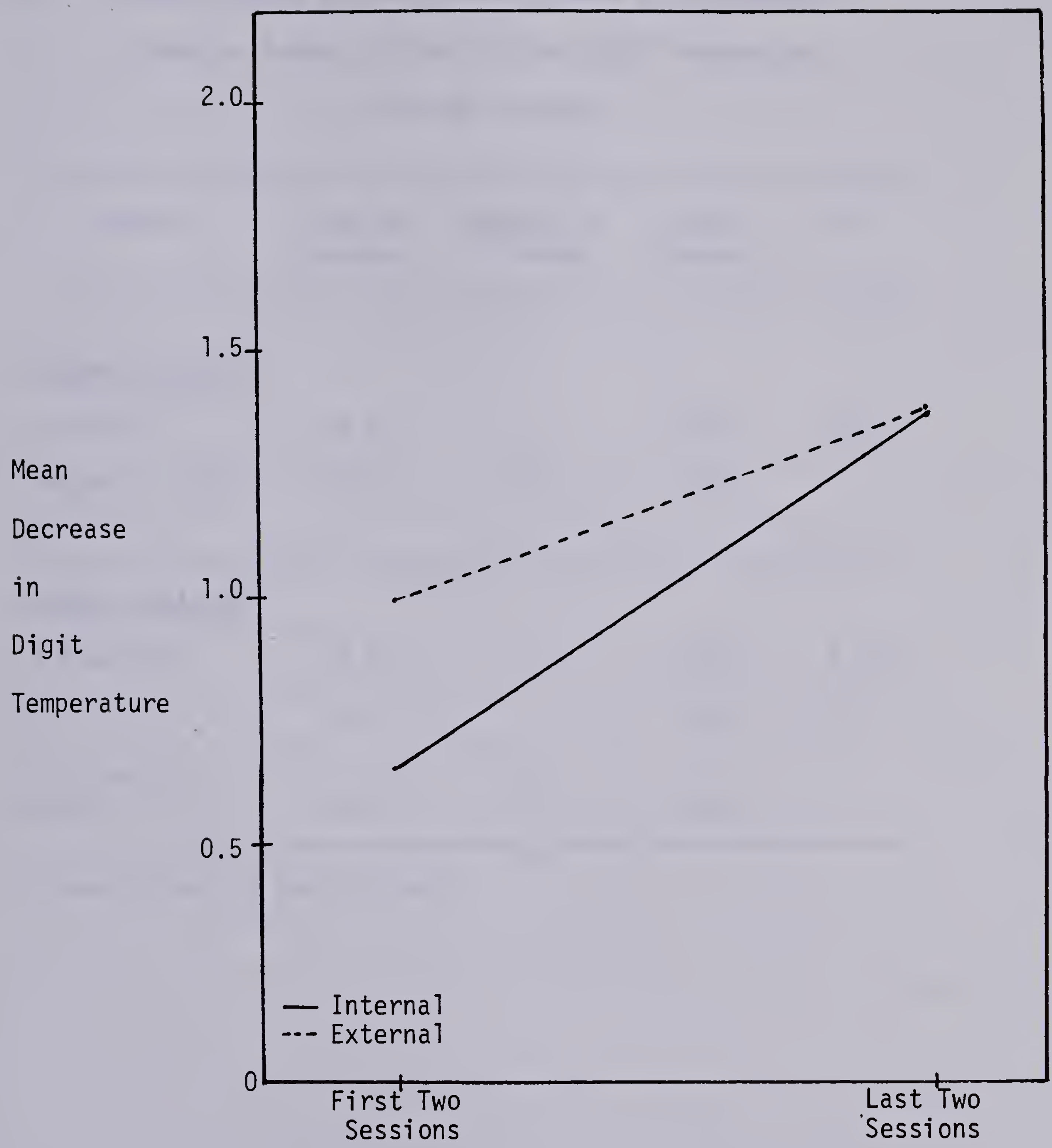

Figure 5

Mean Decrease in Digit Temperature for First Two Sessions Combined and Last Two Sessions Combined for Internal and External Subjects

Table 10

A Two (Group) by Two (Period) ANOVA with Repeated Measures Summary Table for the Digit Temperature Decrease Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	0.39	1	0.39	0.70
Subjects within	12.40	22	0.56	
Within Subjects				
B (Session)	3.61	1	3.61	7.10*
AB	0.36	1	0.36	0.71
B x Subjects within	11.20	22	0.51	

* significant at the .05 level

difference between internal and external subjects with regard to the mean decrease in their digit temperature from the first two to the last two sessions. The Analysis of Variance indicated a significant session effect: $F(1,22) = 7.10$, $p < .05$. The significant session effect indicated that both groups obtained a significant decrease in digit temperature from the first two to the last two sessions.

The results do not support Hypothesis 4. Internal subjects did not attain a greater decrease in digit temperature than external subjects.

Hypothesis 5

It was hypothesized that internal locus of control subjects would be more successful in reducing the frequency and intensity of their migraine headaches than external locus of control subjects.

Hourly headache intensity ratings for each subject were averaged to obtain a mean headache rating per day for each period including pre-treatment, treatment, and post-treatment. This score was computed as Hr/d, where Hr = sum of headache ratings over the experimental period being considered and d = number of days in the experimental period. The headache intensity variable was selected for use because of its sensitivity to changes in headache frequency and intensity (Blanchard et al., 1978).

Headache data were subjected to a two (group) by two (treatment) by three (period) Analysis of Variance with repeated measures. The group means are listed in Table 11 and portrayed graphically in Figure 6. A summary of the Analysis of Variance appears in Table 12.

The Analysis of Variance did not reveal a significant group by period interaction effect. This suggests that there was no significant difference between internal and external subjects with regard to the

Table 11

Mean Headache Levels for Internal and External Subjects (N=48)

Group	Treatment	Period		
		Pre-treatment (P1)	Treatment (P2)	Post-treatment (P3)
Internal	EMG	10.26	8.21	6.56
	Temperature	15.65	15.41	15.43
External	EMG	11.44	7.84	5.18
	Temperature	11.48	11.69	6.38

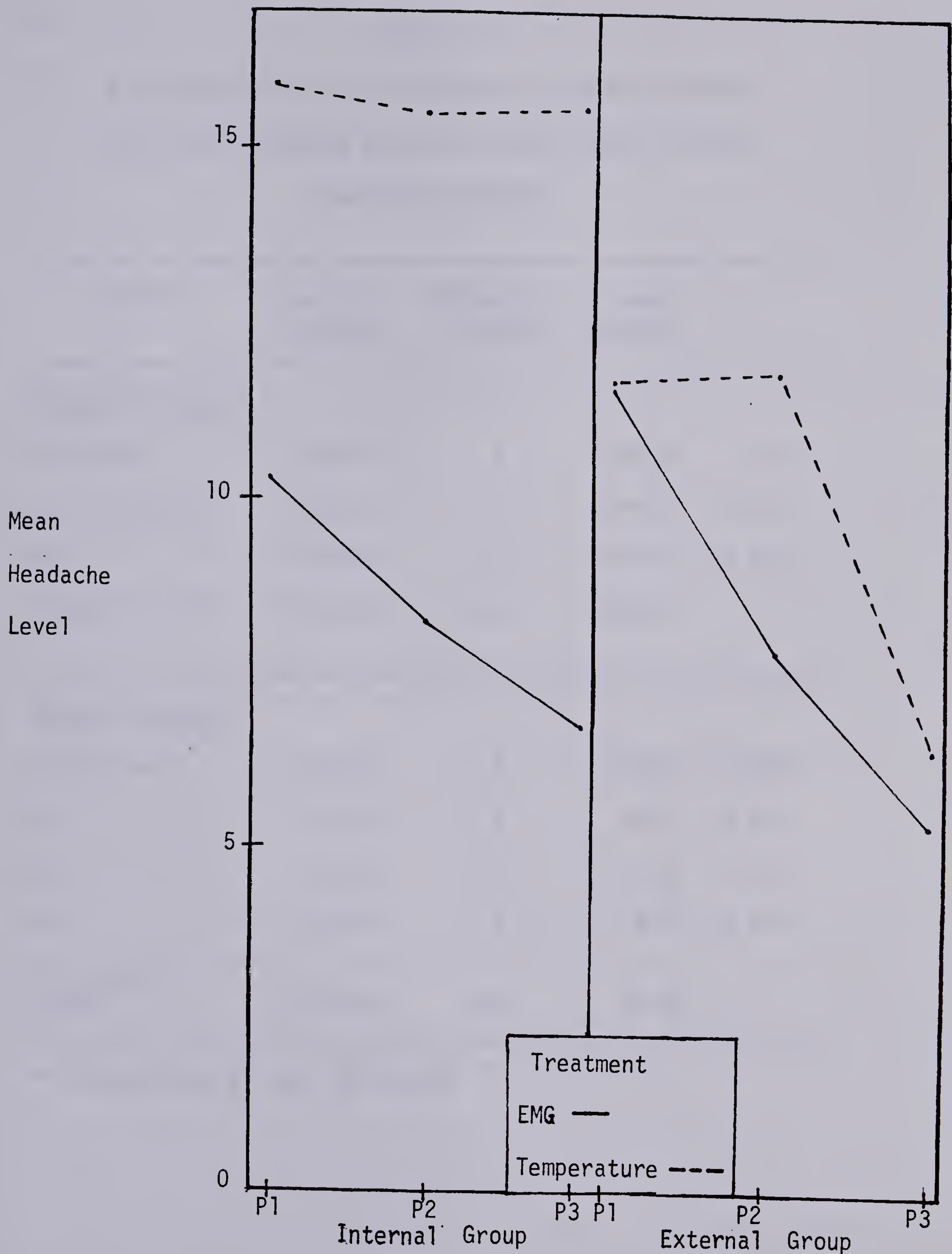

Figure 6

Mean Headache Levels Across Experimental Periods for Internal and External Subjects

Table 12

A Two (Group) by Two (Treatment) by Three (Period) ANOVA with Repeated Measures Summary Table for the Headache Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	306.41	1	306.41	1.20
B (Treatment)	705.12	1	705.12	2.75
AB	267.74	1	267.74	1.05
Subjects within	11273.29	44	256.21	
Within Subjects				
C (Period)	357.95	2	178.97	8.26**
AC	97.21	2	48.61	2.24
BC	54.18	2	27.09	1.25
ABC	28.00	2	14.00	0.65
C x Subjects within	1907.58	88	21.68	

** significant at the .001 level

mean reduction in their headache frequency and intensity from pre-treatment to post-treatment. The Analysis of Variance indicated a significant period effect: $F(2,88) = 8.26$, $p = .001$. The significant period effect indicated that both groups obtained a significant reduction in the frequency and intensity of their migraine headaches from the pre-treatment to the post treatment period.

The results do not support Hypothesis 5. Internal subjects were not more successful in reducing the frequency and intensity of their migraine headaches than external subjects.

The headache data were reanalyzed using a two (group) by two (treatment) by two (period) Analysis of Variance with repeated measures. The two periods were pre-treatment and post-treatment. The treatment period was taken out of the analysis because it was thought that the variability during treatment may have masked any group or interaction effects. The results, however, were not different from the initial analysis and so are not reported here.

<u>Hypothesis 6</u>

It was hypothesized that field independent subjects would acquire more rapid control over their EMG and digit temperature responses i.e. they would meet weaning criterion sooner than field dependent subjects.

Criterion data were subjected to a two (group) by two (treatment) Analysis of Variance. The group means and standard deviations are listed in Table 13. A summary of the Analysis of Variance appears in Table 14.

The Analysis of Variance did not reveal a significant group by treatment interaction effect. This suggests that there was no significant difference between field independent and field dependent subjects with regard to the mean number of sessions taken to meet criterion.

Table 13

Mean Number of Sessions to Criterion for Field Independent and Field Dependent Subjects (N=48)

Group		Treatment	
		EMG	Temperature
Field Independent	Mean	5.92	11.17
	S.D.	2.87	2.86
Field Dependent	Mean	7.25	11.08
	S.D.	3.14	2.78

Table 14

A Two (Group) by Two (Treatment) ANOVA Summary Table for the Criterion Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
<u>Between Subjects</u>				
A (Group)	4.69	1	4.69	0.55
B (Treatment)	247.52	1	247.52	29.15**
AB	6.02	1	6.02	0.71
Within	373.75	44	8.49	

** significant at the .001 level

The Analysis of Variance indicated a significant treatment effect for the criterion variable: $F(1,44) = 29.15$, $p < .001$. The significant treatmenteffect indicated that subjects who received EMG biofeedback met criterion sooner than subjects who received digit temperature biofeedback.

The results do not provide support for Hypothesis 6. Field independent subjects did not meet weaning criterion sooner than field dependent subjects.

Hypothesis 7

It was hypothesized that field independent subjects who received EMG biofeedback training would attain a greater decrease in EMG levels than field dependent subjects who received EMG biofeedback training.

The 15 EMG readings obtained during the three 5 minute practice sessions were averaged for each subjects' first two and last two sessions. If the subject met criterion during treatment the session at which they met criterion was considered their last session.

EMG treatment data were subjected to two (group) by two (session) Analysis of Variance with repeated measures. The group means are listed in Table 15 and portrayed graphically in Figure 7. A summary of the Analysis of Variance appears in Table 16.

The Analysis of Variance did not reveal a significant group by session interaction effect. This suggests that there was no significant difference between field independent and field dependent subjects with regard to the mean reduction in their EMG levels from the first two sessions to the last two sessions. The Analysis of Variance indicated a significant session effect: $F(1,22) = 28.74$, $p = .001$. The significant session effect indicated that both groups obtained a signifi-

Table 15

Mean EMG Levels for the First Two Sessions Combined and the Last Two Sessions Combined for Field Independent and Field Dependent Subjects (N=24)

Group		Session	
		First Two	Last Two
Field Independent	Mean	1.51	1.09
	S.D.	0.48	0.31
Field Dependent	Mean	1.97	1.30
	S.D.	0.71	0.27

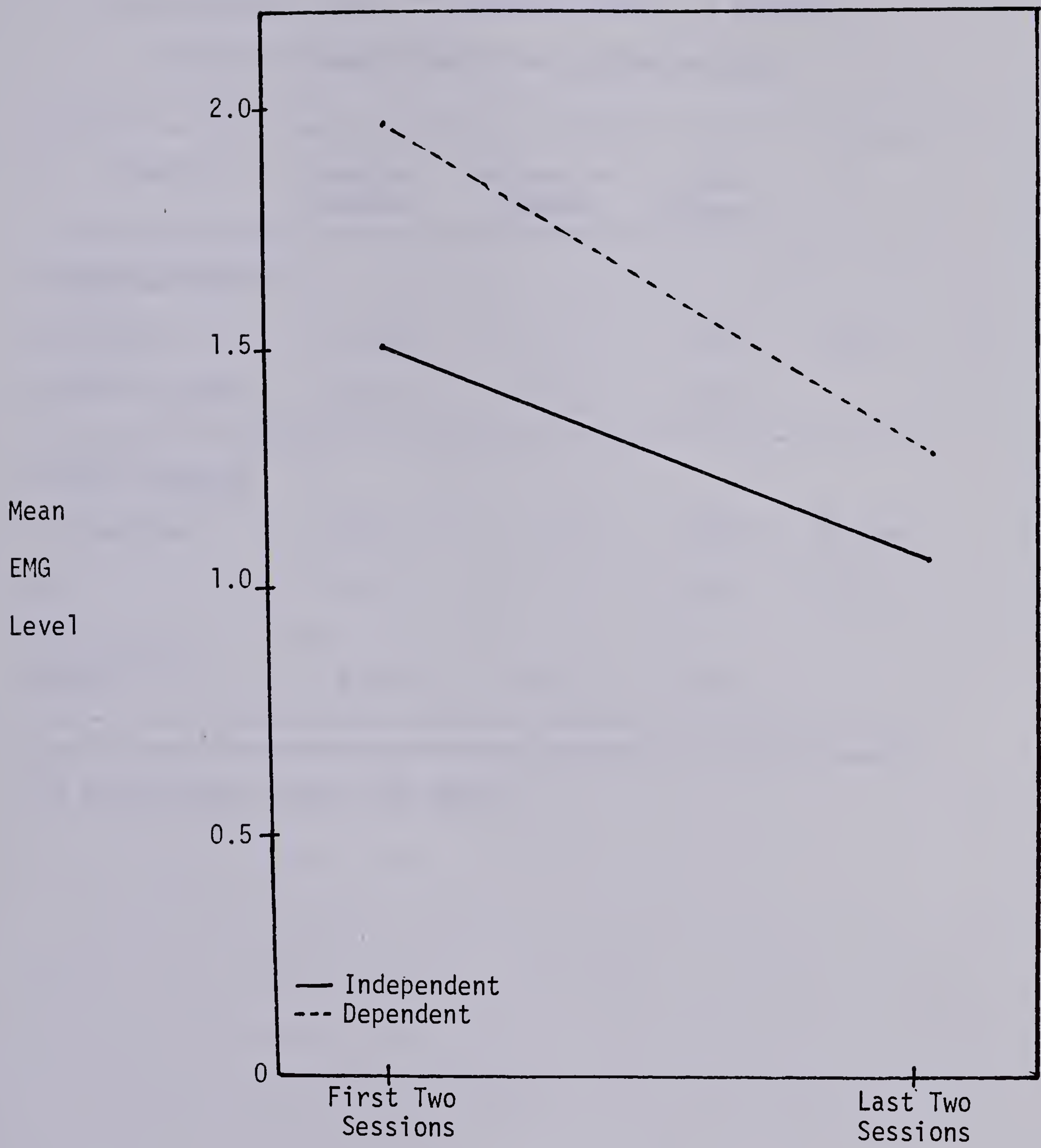

Figure 7

Mean EMG Levels for First Two Sessions Combined and Last Two Sessions Combined for Field Independent and Field Dependent Subjects

Table 16

A Two (Group) by Two (Treatment) ANOVA with Repeated Measures Summary Table for the EMG Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	1.38	1	1.38	4.20
Subjects within	7.25	22	0.33	
Within Subjects				
B (Session)	3.55	1	3.55	28.74**
AB	0.19	1	0.19	1.53
B x Subjects within	2.72	22	0.12	

** significant at the .001 level

cant reduction in EMG levels from the first two to the last two sessions.

The results do not provide support for Hypothesis 7. Field independent subjects did not attain a greater decrease in EMG levels than field dependent subjects.

Hypothesis 8

It was hypothesized that field independent subjects who received digit temperature biofeedback training would attain a greater increase in their digit temperature than field dependent subjects who received digit temperature biofeedback training.

The increase in digit temperature was calculated for each 5 minute practice period during which the subject had been instructed to increase their digit temperature. A mean digit temperature increase was then obtained for the first two sessions combined and last two sessions combined. An overall mean increase for the two periods (first and last) was then obtained for the field independent group and for the field dependent group.

The digit temperature increase data was then subjected to a two (group) by two (period) Analysis of Variance with repeated measures. The group increase means are listed in Table 17 and portrayed graphically in Figure 8. A summary of the Analysis of Variance appears in Table 18.

The Analysis of Variance did not reveal a significant group by session interaction effect. This suggests that there was no significant difference between field independent and field dependent subjects with regard to the mean increase in their digit temperature from the first two to the last two sessions. The Analysis of Variance indicated

Table 17

Mean Increase in Digit Temperature for the First Two Sessions Combined and the Last Two Sessions Combined for Field Independent and Field Dependent Subjects (N=24)

Group		Session	
		First Two	Last Two
Field Independent	Mean	0.89	1.42
	S.D.	0.73	1.10
Field Dependent	Mean	0.71	1.32
	S.D.	0.70	0.72

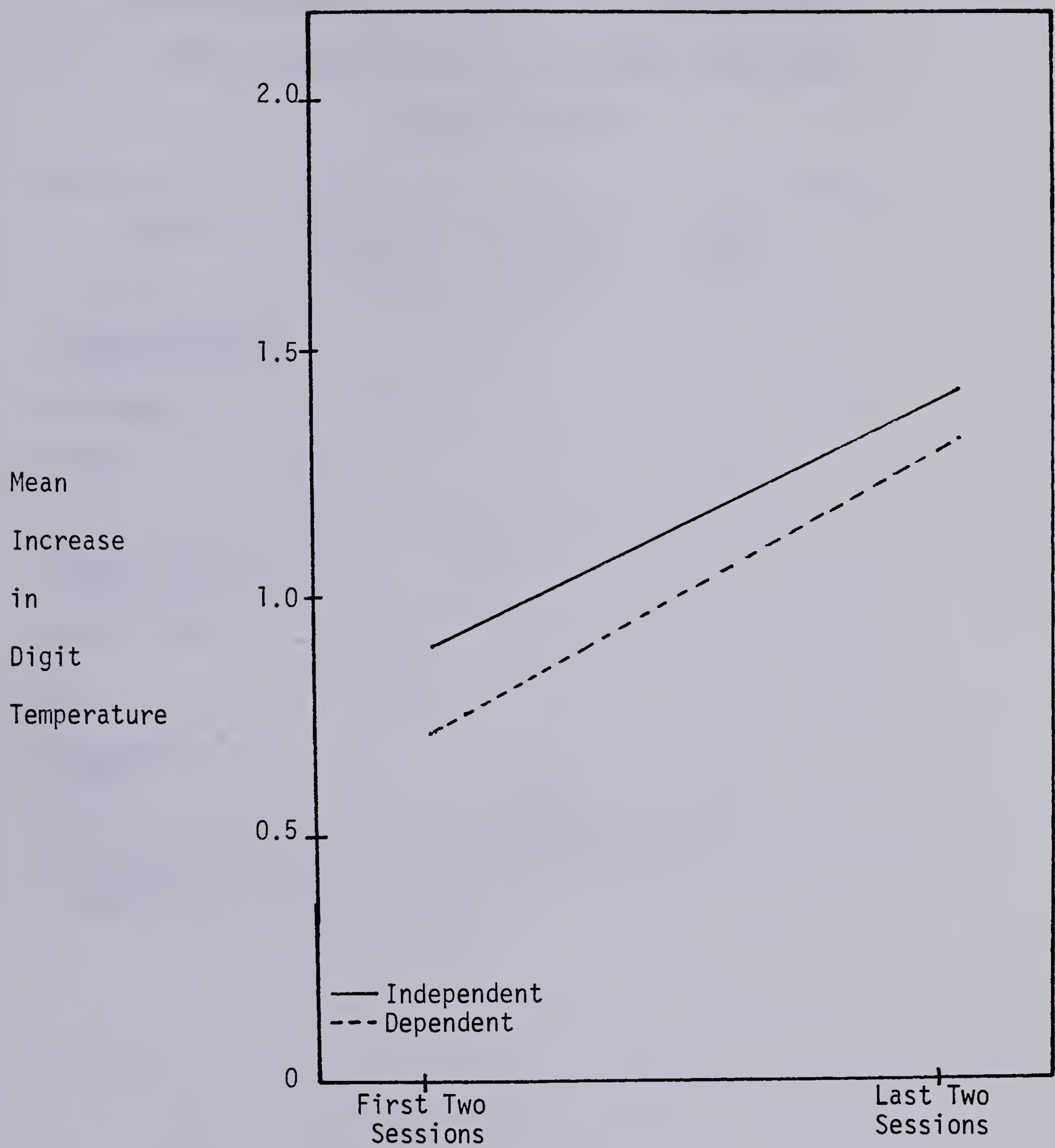

Figure 8

Mean Increase in Digit Temperature for First Two Sessions Combined and Last Two Sessions Combined for Field Independent and Field Dependent Subjects

Table 18

A Two (Group) by Two (Period) ANOVA with Repeated Measures Summary Table for the Digit Temperature Increase Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
<u>Between Subjects</u>				
A (Group)	0.24	1	0.24	0.29
Subjects within	18.17	22	0.83	
<u>Within Subjects</u>				
B (Session)	3.92	1	3.92	7.06*
AB	0.02	1	0.02	0.04
B x Subjects within	12.22	22	0.55	

* significant at the .05 level

a significant session effect: $F(1,22) = 7.06$, $p < .05$. The significant session effect indicated that both groups attained a significant increase in digit temperature from the first two to the last two sessions.

The results do not support Hypothesis 8. Field independent subjects did not attain a greater increase in digit temperature than field dependent subjects.

Hypothesis 9

It was hypothesized that field independent subjects who received digit temperature biofeedback training would attain a greater decrease in their digit temperature than field dependent subjects who received digit temperature biofeedback training.

The decrease in digit temperature was calculated for each 5 minute practice period during which the subjects had been instructed to decrease their digit temperature. A mean digit temperature decrease was then obtained for the first two sessions combined and the last two sessions combined. An overall mean decrease for the two periods (first and last) was then obtained for the field independent group and for the field dependent group.

The digit temperature decrease data were then subjected to a two (group) by two (period) Analysis of Variance with repeated measures. The group decrease means are listed in Table 19 and portrayed graphically in Figure 9. A summary of the Analysis of Variance appears in Table 20.

The Analysis of Variance did not reveal a significant group by session interaction effect. This suggests that there was no significant difference between field independent and field dependent subjects with regard to the mean decrease in their digit temperature from the

Table 19

Mean Decrease in Digit Temperature for the First Two Sessions Combined and the Last Two Sessions Combined for Field Independent and Field Dependent Subjects (N=24)

Group		Session	
		First Two	Last Two
Field Independent	Mean	0.73	1.23
	S.D.	0.43	0.88
Field Dependent	Mean	0.98	1.48
	S.D.	0.82	0.74

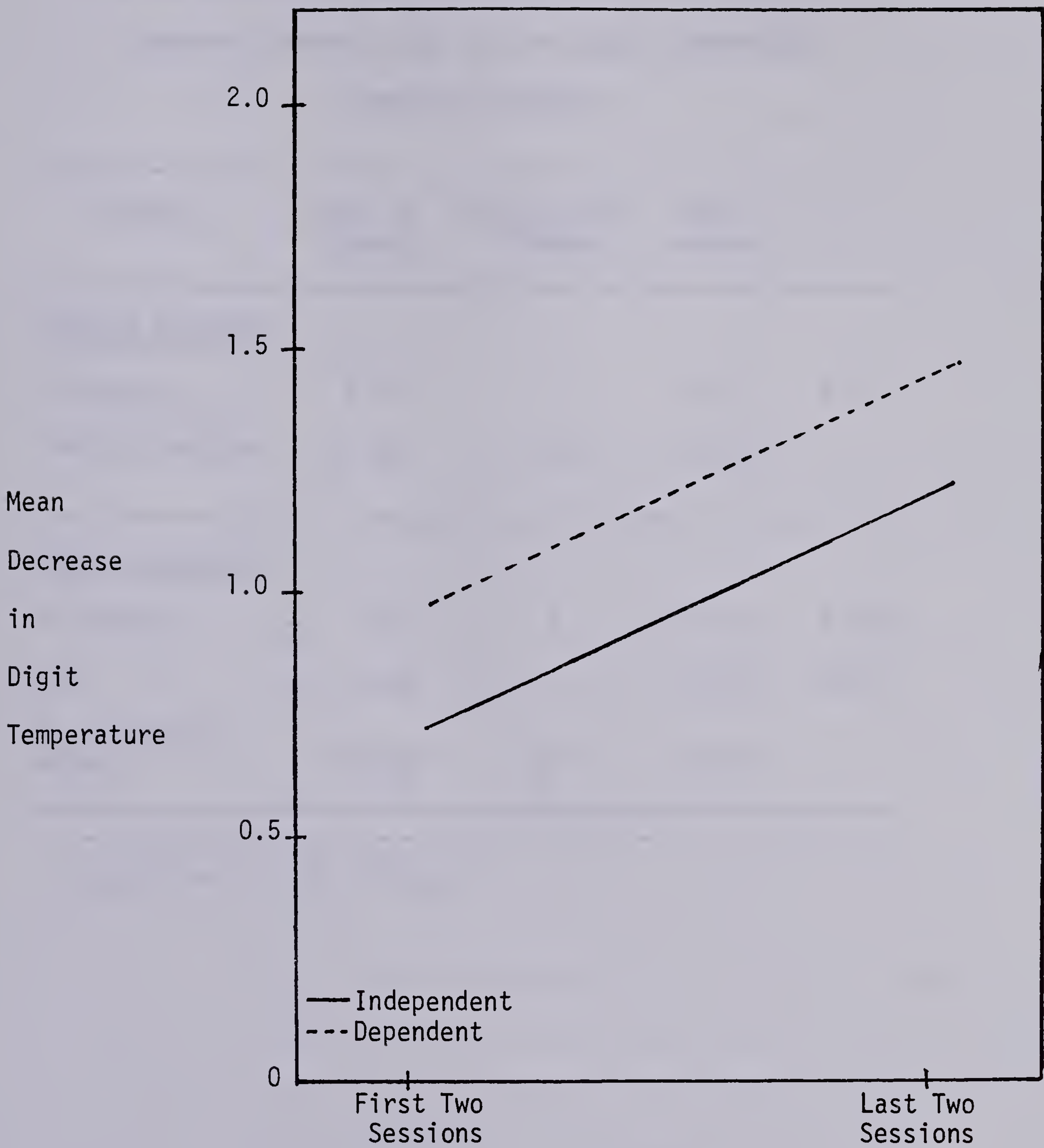

Figure 9

Mean Decrease in Digit Temperatue for First Two Sessions Combined and Last Two Sessions Combined for Field Independent and Field Dependent Subjects

Table 20

A Two (Group) by Two (Session) ANOVA with Repeated Measures Summary Table for the Digit Temperature Decrease Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	0.75	1	0.75	1.41
Subjects within	11.75	22	0.53	
Within Subjects				
B (Session)	3.00	1	3.00	5.38*
AB	0.00	1	0.00	0.00
B x Subjects within	12.26	22	0.56	

* significant at the .05 level

first two to the last two sessions. The Analysis of Variance indicated a significant session effect: $F(1,22) = 5.38$, $p < .05$. The significant session effect indicated that both groups attained a significant decrease in digit temperature from the first two to the last two sessions.

The results do not support Hypothesis 9. Field independent subjects did not attain a greater decrease in their digit temperature than field dependent subjects.

Hypothesis 10

It was hypothesized that field independent subjects would be more successful in reducing the frequency and intensity of their migraine headaches than field dependent subjects.

Headache data were subjected to a two (group) by two (treatment) by three (period) Analysis of Variance with repeated measures. The group means are listed in Table 21 and portrayed graphically in Figure 10. A summary of the Analysis of Variance appears in Table 22.

The Analysis of Variance did not reveal a significant group by period interaction effect. This suggests that there was no significant difference between field independent and field dependent subjects with regard to the mean reduction in the frequency and intensity of their migraine headaches from the pre-treatment to the post-treatment period. The Analysis of Variance indicated a significant period effect: $F(2,88) = 8.60$, $p = .001$. The significant period effect indicated that both groups obtained a significant reduction in the frequency and intensity of their migraine headaches from the pre-treatment to the post-treatment period.

The results do not support Hypothesis 10. Field independent sub-

Table 21

Mean Headache Levels for Field Independent and Field Dependent Subjects (N=24)

Group	Treatment	Period		
		Pre-treatment (P1)	Treatment (P2)	Post-treatment (P3)
Field Independent	EMG	14.37	8.53	8.88
	Temperature	11.59	11.61	8.46
Field Dependent	EMG	8.46	8.08	4.52
	Temperature	15.67	14.93	12.65

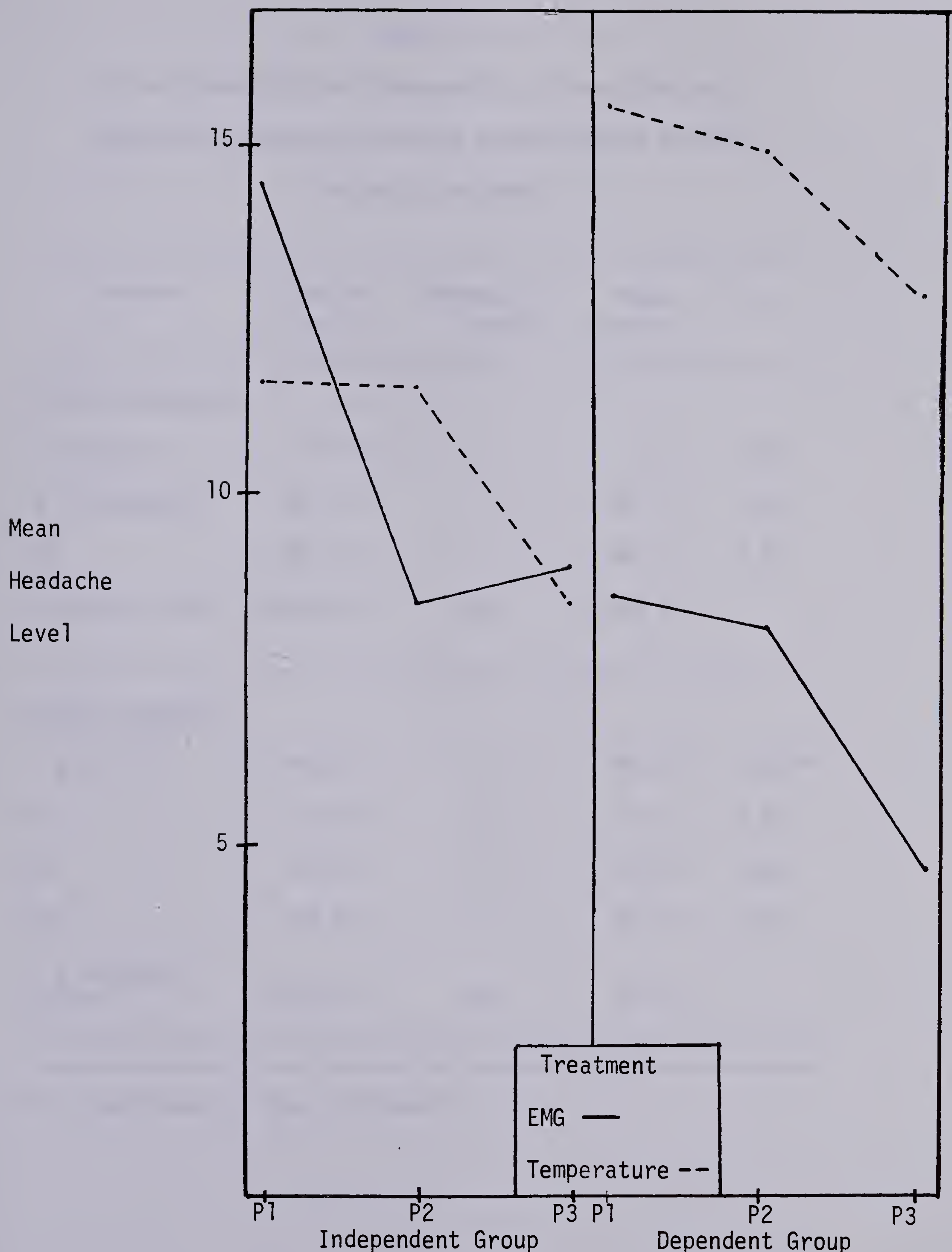

Figure 10

Mean Headache Levels Across Experimental Periods for Field Independent and Field Dependent Subjects

Table 22

A Two (Group) by Two (Treatment) by Three (Period) ANOVA with Repeated Measures Summary Table for the Headache Variable

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F
Between Subjects				
A (Group)	0.73	1	0.73	0.00
B (Treatment)	487.10	1	487.10	1.93
AB	497.15	1	497.15	1.97
Subjects within	11098.56	44	252.24	
Within Subjects				
C (Period)	365.41	2	187.70	8.60**
AC	34.08	2	17.04	0.80
BC	46.18	2	23.09	1.09
ABC	63.72	2	31.86	1.50
C x Subjects within	1870.39	88	21.25	

** significant at the .001 level

jects were not more successful in reducing the frequency and intensity of their migraine headaches than field dependent subjects.

The headache data were reanalyzed using a two (group) by two (treatment) by two (period) Analysis of Variance with repeated measures. The two periods were pre-treatment and post-treatment. The treatment period was taken out of the analysis because it was thought that the variability during treatment may have masked any group or interaction effects. The results, however, were not different from the initial analysis and so are not reported here.

CHAPTER V

5. DISCUSSION

5.1 Introduction

This study investigated the relationship of locus of control and field-dependence-independence to the learning of EMG and digit temperature control through biofeedback training in subjects with migraine headaches. In particular, ten hypotheses were tested, five concerning the locus of control construct and five concerning the field-dependence-independence construct. The data is discussed first in terms of the results pertaining to the locus of control construct and then in terms of the results pertaining to the field-dependence-independence construct. In the final sections of this chapter the practical implications of the present study and suggestions for future research are discussed.

5.2 Summary of results pertaining to the locus of control construct

The hypothesized differences between internal and external subjects on the five measures investigated were not supported by the findings of the present research. It was hypothesized that with auditory and/or visual feedback and social reinforcement internal subjects would acquire control over their EMG and digit temperature responses more quickly, attain a greater decrease in their EMG levels, attain a greater increase in their digit temperature during increase trials, attain a greater decrease in their digit temperature during decrease trials, and reduce the frequency and intensity of their migraine headaches to a greater extent than external subjects.

The pre-treatment EMG and digit temperature levels for the two locus of control groups (internal and external) were compared. The results suggest that the pre-treatment levels were not significantly

[illegible]

different. A number of studies (Carlson, 1977; Gaston, 1976; Stern & Barrenberg, 1977) have tested for differences in baseline levels of EMG between subjects identified according to locus of control orientation and have also found no significant differences.

The mean number of sessions taken to meet criterion by the internal group and the external group were compared. The results suggest that internal subjects did not learn to control their EMG and digit temperature responses at a faster rate than external subjects. Three other studies have compared the speed of acquisition of control of a physiological response through biofeedback for internal and external subjects. Goesling et al. (1974) found that internal subjects were able to increase the density of their alpha rhythm more quickly than external subjects. Reinking (1976) found that internal-high anxiety subjects acquired EMG skill far more rapidly than any other group. Prager-Decker (1978) found that externally controlled individuals trained with biofeedback reduced their EMG levels at a faster rate than internal subjects. The interpretation of the present findings in relation to the findings of these other studies is unclear. First, it may not be possible to compare the control of alpha rhythm to the control of EMG or digit temperature responses. Second, in the Reinking (1976) study it is unclear whether the subject's high anxiety or their internal orientation had the greater effect on the speed of acquisition of the EMG skill. Third, the method used to determine speed of acquisition of control varies from study to study.

It was found that subjects who received EMG biofeedback training learned to control their EMG responses faster than subjects who received digit temperature feedback were able to learn to control their

digit temperature responses. This result suggests that learned bi-directional control of digit temperature may be a more complex and difficult task than learned reduction of EMG levels. This result supports the argument for providing adequate training time when subjects are required to learn control of a physiological response through biofeedback.

Contrary to previous findings which clearly indicate a difference in performance between internal and external subjects in terms of reduction of EMG levels through biofeedback (Carlson, 1977; Herzog, 1976; Prager-Decker, 1978; Reinking, 1976) the data presented in this study were very clear in suggesting that internal and external subjects do not differ in terms of success in reducing EMG levels through biofeedback. Therefore, the present results add to those studies which indicate that there is no difference between internal and external subjects in their ability to decrease EMG levels (Freedman & Papsdorf, 1976; Modell, 1977; Phillips, 1976; Stern & Barrenberg, 1977).

Internal and external subjects did not significantly differ in their performance on the task of increasing digit temperature through biofeedback training. This result supports the findings of Larsen (1977) which suggest that locus of control does not predict success in the biofeedback task of increasing skin temperature.

Similar to the results obtained in the increase in digit temperature task it was found that internal and external subjects did not differ significantly in their ability to decrease digit temperature.

The expected difference between the locus of control groups in terms of a reduction in the frequency and intensity of their migraine headaches was not supported by the results. The results suggest that

there was no significant difference between internal and external subjects with regard to their ability to use EMG or digit temperature biofeedback to reduce the frequency and intensity of their migraine headaches. The lack of a significant difference between groups in terms of headache reduction follows logically from the previous findings which report a lack of a significant difference in ability to control EMG or digit temperature responses. It was assumed that a reduction in headaches would result from the ability to decrease EMG levels and increase digit temperature. Since there was no difference in the ability between internal and external subjects to reduce their EMG levels or increase their digit temperature it would not be expected that there would be a difference in the reduction of their migraine headaches.

It should be noted that the internal group which received digit temperature training had a much higher mean pre-treatment headache level than the other three groups. Also it is evident that this group did not attain a significant reduction in the frequency or intensity of their migraine headaches. It is possible that a high pre-treatment headache level negates the treatment effect of the digit temperature biofeedback training. It is suggested that in future research pre-treatment headache levels be controlled across groups.

In addition to studies which have investigated the relationship between locus of control and learned control of EMG and digit temperature responses and which are, therefore, directly relevant to the present study, other studies have investigated locus of control in relation to learned control of heart rate, alpha rhythm, and GSR. The results of the present study are contrary to those studies which

found a significant difference between internal and external subjects with regard to their ability to learn control of these various physiological functions (heart rate, alpha, and GSR) through biofeedback (Blankstein & Egner, 1977; Fotopoulos, 1970; Goesling et al., 1974; Greer, 1974; Johnson & Meyer, 1974; Ray, 1974; Ray & Lamb, 1974; Schneider et al., 1977; Wagner et al., 1974).

Two studies, Ray and Lamb (1974) and Ray (1974) found that internal subjects are better able to increase their heart rate and external subjects are better able to decrease their heart rate. Lang and Twentyman (1974) discuss the fact that heart rate slowing develops gradually over a session, whereas heart rate speeding shows very rapid acquisition and they hypothesize that the raising and the lowering of heart rate are mediated by different psychophysiological mechanisms. In view of the suggestions of Lang and Twentyman, the findings of Ray and Lamb (1974) and Ray (1974) and the present research it seems reasonable to suggest that different physiological responses need to be considered separately in terms of their relationship to locus of control. It may not be feasible to consider learned control of physiological responses through biofeedback in a global manner since the learned control of different physiological responses may require different skills or techniques.

5.3 Explanations for negative results

The present study was different from previous research that has investigated the relationship between locus of control and the control of EMG and digit temperature responses through biofeedback in: the use of a clinically relevant sample i.e. migraine headache sufferers, attempting to ensure that subjects were well motivated i.e. subjects

were told that learned control of their EMG or digit temperature responses would likely result in a decrease in the frequency and intensity of their migraine headaches, providing adequate training time (four to twelve sessions), and providing social reinforcement in addition to the biofeedback.

In terms of the procedures used in the present study there are a number of possible explanations for the negative results obtained. Using a median split procedure to identify two groups according to their scores on Rotter's I-E scale may not be sufficient to identify two groups who will perform differently in terms of self-control of EMG and digit temperature responses through biofeedback. It is possible that the Rotter scale does not differentiate between subjects whose scores fall at the middle of the distribution.

Secondly, the negative results may be directly related to the sample studied. Most previous research investigating the relationship between locus of control and learned control of a physiological response through biofeedback used samples comprised of university students. The present study used a clinically relevant sample consisting of migraine headache sufferers. The results suggest, therefore, that for migraine headache sufferers locus of control may not be a good predictor of success in learning control of EMG and digit temperature responses through biofeedback.

A third possible explanation for the negative results pertains to subject motivation. In most previous research the only indication of subject motivation was the fact that subjects were willing to participate in experiments investigating the relationship between locus of control and biofeedback in order to obtain a required course credit.

In the present research it is assumed that subject motivation to succeed in the biofeedback task is much stronger than in previous research for a number of reasons: subjects were volunteers, subjects were required to pay $50.00 in order to participate, and subjects were told that success in the biofeedback task was expected to lead to a reduction in the frequency and intensity of their migraine headaches. The majority of subjects had suffered from migraine headaches for a number of years, had sought various forms of relief (including acupuncture, physiotherapy, psychotherapy, drug therapy, and yoga) all without lasting success, and were most anxious to obtain relief from their headaches. The results of the present research suggest, then, that the strong motivation of the subjects may have negated any differential effects in performance expected as a result of differing locus of control orientations.

A fourth possible explanation for the negative results concerns the number of training sessions provided. Most previous research investigating the relationship between locus of control and learned control of a physiological response through biofeedback provided inadequate training time. The present study set a criterion level of success and provided subjects with a minimum of four and a maximum of twelve training sessions. The present results suggest that when provided with an adequate amount of training time the difference between internal and external subjects in terms of learned control of EMG and digit temperature responses becomes insignificant. Gatchel (1975) found that the difference between internal and external subjects in terms of ability to control heart rate through biofeedback became nonsignificant when subjects were provided with only one additional

session to what they had received in previous studies which showed a difference between groups.

5.4 Theoretical implications

The different procedures used in the present study as compared to those of previous research and some possible effects of the procedures used may account for the negative results obtained. However, there still exists the discrepancy between the results obtained and the theory which guided the present research and led to the hypotheses. Two explanations will be provided to attempt to explain this discrepancy.

The finding that internal subjects did not perform better than external subjects, particularly in terms of the specific biofeedback tasks, suggests the rather paradoxical conclusion that internal subjects' active attempt to perform well may actually have interfered with the attainment of a "passive" attitude which is necessary in biofeedback training.

A second possible explanation for the negative results concerns the provision of social reinforcement (in the form of verbal praise and encouragement by the experimenter) and the actual presence of the experimenter during the training sessions. Lefcourt (1976), summarizing a number of studies states that "the overall evidence, then, consistently suggests that externals are more attentive, positively responsive, and facilitated in their task performances by the presence of social cues. Internals, on the other hand, seem to be more resistant to social influences and are, at the least, distracted by social cues as they attempt to cope with various tasks" (p. 145). The results of the present study suggest the possibility that the provision of social reinforcement

and the presence of the experimenter may have had a debilitating effect on internal subjects' performance and a facilitating effect on external subjects' performance.

5.5 Summary of results pertaining to the field-dependence-independence construct

The results pertaining to the field-dependence-independence construct were essentially the same as those pertaining to the locus of control construct. The hypothesized differences between field independent and field dependent subjects were not supported by the findings of the present research.

The pre-treatment EMG and digit temperature levels for the field dependent and field independent groups were compared. The pre-treatment levels showed no consistent differences attributable to the field-dependence-independence variable. The present finding is contrary to those studies which suggest differences in physiological functioning between field independent and field dependent subjects (Cohen et al., 1962; Hustmyer & Karnes, 1964). The findings of these studies suggest that field dependent subjects would be more likely than field independent subjects to show excessive or maladaptive physiological discharge or more prolonged physiological arousal when confronted with unstructured, novel, or threatening situations. The present finding suggests that the novel environment which contained complex biofeedback machinery was not more threatening or arousing to field dependent subjects as compared to field independent subjects.

Due to the paucity of previous research concerning the relationship of the field-dependence-independence construct to success in learning control of physiological responses through biofeedback the

results of the present study in light of previous research are difficult to interpret. The present study found no difference between the two groups of subjects in terms of ability to decrease their EMG levels. The present findings concerning control of digit temperature support the findings of Lovett (1977) who found no significant difference between field independent and field dependent subjects in terms of ability to control skin temperature. The expected difference between the two groups of subjects in terms of ability to reduce the frequency and intensity of their migraine headaches was also not supported by the present results.

5.6 Explanations for negative results

The negative results obtained may be related to specific procedures used in the present study. Using a median split procedure to identify two groups according to their scores on the GEFT may not be sufficient to identify two groups who will perform differently in terms of self-control of EMG and digit temperature responses through biofeedback. It is possible that the GEFT does not differentiate between subjects whose scores fall at the middle of the distribution.

The negative results obtained may also be a function of: the particular sample used i.e. migraine headache sufferers as compared to the university student samples or 'normal' adult samples used in previous research, the stronger motivation of the migraine headache sufferers to succeed in the biofeedback task, the increase in the number of training sessions provided, four to twelve, as compared to most of the previous research studies which provided only one session of training, and the provision of social reinforcement in addition to the biofeedback.

5.7 Theoretical implications

Concerning the discrepancy between the results obtained and the theory which guided the present research and led to the hypotheses concerning the relationship between the field-dependence-independence construct and learned self-control through biofeedback two explanations will be provided.

Goodenough (1976) suggests that field independent subjects use a "participant" approach to learning whereas field dependent subjects more often use a "spectator" approach (p. 675). The finding that field independent subjects did not perform better than field dependent subjects, particularly in terms of the specific biofeedback tasks, suggests the paradoxical conclusion that the field independent subjects' approach to and involvement in the task may have interfered with the attainment of the "passive" attitude necessary to achieve success in biofeedback training.

The second explanation for the negative results relates to the provision of social reinforcement (in the form of verbal praise and encouragement by the experimenter) and the presence of the experimenter and two subjects during the training sessions. Witkin and Goodenough (1977) discuss evidence from recent research on social behavior and suggest that field dependent people are likely to have an interpersonal orientation, whereas field independent people have an impersonal orientation. For example, field dependent people more than field independent people: pay selective attention to social cues, favor interpersonal over solitary situations, are interested in people and like being with others, and more readily disclose their feelings and thoughts to others. In contrast field independent people have been described

as concerned with ideas and principles rather than people and cold and distant in relation to others. It is suggested that the necessity of interacting with another subject, the opportunity of discussing with the experimenter (and possibly the other subject) any concerns or questions related to performance on the biofeedback tasks, and the social reinforcement provided by the experimenter facilitated the field dependent subjects' performance but may have been detrimental to the performance of field independent subjects.

5.8 Practical implications

There appear to be two practical implications of the present research findings. First, the overall finding that locus of control and field-dependence-independence do not appear to predict success in learned control of internal bodily processes suggests that this may not be a fruitful area for investigation. The present finding is of particular import in that a clinically relevant sample was used. Holiday and Munz (1978) found a relationship between locus of control and reduction of EMG levels in a nonpsychosomatic group but not in a psychosomatic group.

Second, it was apparent from the results that subjects were able to produce the desired changes. One can conclude that subjects can learn to control their EMG and digit temperature responses and can reduce their migraine headaches when provided with appropriate biofeedback. The use of EMG and digit temperature in the treatment of migraine headaches is, therefore, supported by the present research.

Although there were no significant findings relating to the relationship between the two constructs studied and the control of physiological processes through biofeedback it is concluded that further

research in this area could prove productive.

5.9 Suggestions for future research

More research is necessary in comparing the relationship between locus of control and field-dependence-independence and learned control of physiological functions through biofeedback. Either replications of this study or similar studies which improve upon the shortcomings of the present research could provide convergent validation for the present findings and enable one to assess the extent to which the variables investigated are related.

The present study could have been better designed to determine if the locus of control and field-dependence-independence constructs are related to success in learning control of EMG and digit temperature responses through biofeedback. Some suggested improvements include: using more than one measure of internality-externality and field-dependence-independence and selecting only those subjects who perform consistently across measures, selecting only those subjects who score one standard deviation above and one standard deviation below the mean on a particular measure, and the use of a larger sample. Interesting results might be attained in similar research using other clinically relevant samples. It would also be interesting to assign subjects to different groups to study the effects upon performance in a biofeedback task of: different levels of motivation, different types of reinforcement, and experimenter presence or absence.

One further question for future research concerns the relationship between the locus of control construct and the field-dependence-independence construct. The similarity of the two constructs has been noted by Lefcourt and Telegdi (1971) and Rotter (1966). It would be inter-

esting to study whether those subjects who score congruently on the two measures i.e. internal-field independent and external-field dependent subjects perform consistently better than subjects who score incongruently on the two measures i.e. internal-field dependent and external-field independent.

Further research into the identification of a particular measure or combination of measures which would enable one to reliably predict success in biofeedback training is a worthwhile endeavor. The discovery of a measure which could predict success in biofeedback training would greatly increase the efficiency of the selection of treatment procedures in that a different treatment mode could be selected for those subjects whose performance on the measure contraindicates the use of biofeedback training.

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REFERENCE NOTE

1. Migraine Headache Study, University of Alberta, 1980-1981. Appendices A, B, C, E, G, H, I, and J were developed by the researchers involved in the migraine headache study under the direction of Dr. George Fitzsimmons.

APPENDIX A

Inclusion Criteria

Name: ____________________ Address: ____________________

Phone: ____________________ Sex: ____________________

1. What is your age? ____(18 to 59)
2. How often have your headaches occurred in the last 2 months? ____(less than 3X/day & greater than 1/mo.)
3. Do you take any medication for your headache? ____________

   What is the name of the medication? ____________

   How well does it control headache? ____________(Doesn't)

   Currently using oral contraceptives? ____; pregnant? ____(no)

   Are you on any other medications? Specify: ____________
4. Have your headaches occurred one or more times per month over the past 2 years? ____________(yes)
5. Are you currently receiving any form of psychotherapy? ____________(no)
6. Do you ever experience sensory losses or paralysis of some muscles during a headache? ____________(no)
7. Do you suffer from a convulsive disorder (epileptic seizures)? ____________(no)
8. Do you have any form of heart disease or disorder? ____________(no)
9. Do you have any health problems such as diabetes, hypertension, etc? Specify: ____________

SUBJECT MUST REPORT "YES" TO THREE OF THE FOLLOWING ITEMS:

1. Does the head pain sometimes exist on one side of the head only?
2. Is the head pain generally pulsative (or throbbing)?
3. Does nausea or vomiting generally accompany the headache?
4. Does sensitivity to light generally accompany the headache?
5. Has your headache been diagnosed as a migraine by your physician?

(see Reference Note 1)

APPENDIX B

Medical Form

Name of Physician: ______________________

Name of Patient: ______________

Date of Birth: ______________

Address: ______________________

____

Phone: ______________________

The above named patient has been selected to participate in a treatment program for migraine patients being conducted at the University of Alberta, Department of Educational Psychology. This research is being supervised by Dr. George Fitzsimmons. The techniques being used may include relaxation training and psychophysiological monitoring including electromyography, galvanic skin response, and surface skin temperature.

We are requesting each patient to obtain the signature of their physician to verify that they have received a recent medical examination and to ensure that there is no medical reason why they should not participate in the research project.

For Physician

(A) This is to certify that ______________________ has been medically examined and I do not advise against his/her participation in the program described.

(B) I _______ (do, do not) agree that the headache pain which this person reports is of the migraine form.

Date: ______________________

Physician's Signature: ______________________

(see Reference Note 1)

APPENDIX C

Treatment Contract

Participant - I understand that my participation in the migraine treatment program will require my full cooperation in each of the following components of the study:

1. Punctual attendance at all treatment sessions scheduled;
2. Attendance at one pre-training orientation session held several days before treatment and one post-treatment follow-up session held one month after the treatment period;
3. One half-hour daily practice of specific relaxation skills learned in treatment to continue throughout the training period;
4. Hourly monitoring of headache activity and medication consumption prior to and throughout the training period;
5. Keeping a headache diary for one year following the treatment period;
6. Notifying your counsellor by phoning 432-5214 (during regular office hours) if unable to keep a scheduled appointment.
7. Notifying the Department of Educational Psychology, 6th floor-Education North, University of Alberta should your address change.

Date: ______________________ Signature: ____________________

Counsellor - I promise that all records of Participants: names, addresses and personal information will be kept confidential. At the completion of this study a summary of the results obtained shall be made available to all those who fully participated.

Date: ______________________ Signature: ____________________

(see Reference Note 1)

APPENDIX D

INSTRUCTIONS:

This is a questionnaire to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Please select the one statement of each pair (and only one) which you more strongly believe to be the case as far as you're concerned. Be sure to select the one you actually believe to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief: obviously there are no right or wrong answers.

Your answers to the items on this inventory are to be recorded on a separate answer sheet which is loosely inserted in the booklet. REMOVE THIS ANSWER SHEET NOW. Print your name and any other information requested by the examiner on the answer sheet, then finish reading these directions. Do not open the booklet until you are told to do so.

Please answer these items carefully but do not spend too much time on any one item. Be sure to find an answer for every choice. Find the number of the item on the answer sheet and black-in the space under the number 1 or 2 which you choose as the statement more true.

In some instances you may discover that you believe both statements or neither one. In such cases, be sure to select the one you more strongly believe to be the case as far as you're concerned. Also try to respond to each item independently when making your choice; do not be influenced by your previous choices.

1. a. Children get into trouble because their parents punish them too much.

   b. The trouble with most children nowadays is that their parents are too easy with them.

2. a. Many of the unhappy things in people's lives are partly due to bad luck.

   b. People's misfortunes result from the mistakes they make.

3. a. One of the major reasons why we have wars is because people don't take enough interest in politics.

   b. There will always be wars, no matter how hard people try to prevent them.

4. a. In the long run people get the respect they deserve in this world.

   b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

5. a. The idea that teachers are unfair to students is nonsense.

   b. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. a. Without the right breaks one cannot be an effective leader.

   b. Capable people who fail to become leaders have not taken advantage of their opportunities.

7. a. No matter how hard you try some people just don't like you.

   b. People who can't get others to like them don't understand how to get along with others.

8. a. Heredity plays the major role in determining one's personality.

   b. It is one's experiences in life which determine what they're like.

9. a. I have often found that what is going to happen will happen.

   b. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10. a. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.

    b. Many times exam questions tend to be so unrelated to course work that studying is really useless.

11. a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.

    b. Getting a good job depends mainly on being in the right place at the right time.

12.a. The average citizen can have an influence in government decisions.

b. This world is run by the few people in power, and there is not much the little guy can do about it.

13.a. When I make plans, I am almost certain that I can make them work.

b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.

14.a. There are certain people who are just no good.

b. There is some good in everybody.

15.a. In my case getting what I want has little or nothing to do with luck.

b. Many times we might just as well decide what to do by flipping a coin.

16.a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.

b. Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.

17.a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.

b. By taking an active part in political and social affairs the people can control world events.

18.a. Most people don't realize the extent to which their lives are controlled by accidental happenings.

b. There really is no such thing as "luck".

19.a. One should always be willing to admit mistakes.

b. It is usually best to cover up one's mistakes.

20.a. It is hard to know whether or not a person really likes you.

b. How many friends you have depends upon how nice a person you are.

21.a. In the long run the bad things that happen to us are balanced by the good ones.

b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22.a. With enough effort we can wipe out political corruption.

b. It is difficult for people to have much control over the things politicians do in office.

23.a. Sometimes I can't understand how teachers arrive at the grades they give.

b. There is a direct connection between how hard I study and the grades I get.

24.a. A good leader expects people to decide for themselves what they should do.

b. A good leader makes it clear to everybody what their jobs are.

25.a. Many times I feel that I have little influence over the things that happen to me.

b. It is impossible for me to believe that chance or luck plays an important role in my life.

26.a. People are lonely because they don't try to be friendly.

b. There's not much use in trying too hard to please people, if they like you, they like you.

27.a. There is too much emphasis on athletics in high school.

b. Team sports are an excellent way to build character.

28.a. What happens to me is my own doing.

b. Sometimes I feel that I don't have enough control over the direction my life is taking.

29.a. Most of the time I can't understand why politicians behave the way they do.

b. In the long run the people are responsible for bad government on a national as well as on a local level.

Note. From "Generalized Expectancies for Internal versus External Control of Reinforcement" by J. B. Rotter, Psychological Monographs, 1966, 80, No. 1 (Whole No. 609), 11-12.

APPENDIX E

Psychophysiological Profile Procedure

1. Record room temperature.

2. Seat subject in recliner chair and tilt chair to the first recliner position. Inquire whether a headache is now present and if so reschedule the session.

3. Hook-Up GSR - dominant hand; Temperature - nondominant hand; EMG - frontal area with electrodes spaced at 1 inch.

4. Explanation "Today's session will last approximately 40 minutes. What I am going to do is attach you to 3 biofeedback instruments in order to see what levels of activity you produce in 3 different physiological systems: (1) skin temperature, (2) muscle tension, and (3) skin perspiration (indicate corresponding instrumints). These instruments will not shock you or harm you in any way, they merely attach onto the surface of your skin with these wires. We are hooking you up today in order to find out how your body activity corresponds to your headache pattern, and how the relaxation treatment program changes both your body activity and your headache pattern. Do you have any questions?"

5. Relaxation instructions to be read to the subject. "For the next 5 minutes I would like you to relax comfortably with your eyes open and just listen to the music being played in the background. Try to avoid unpleasant thoughts and just enjoy this 5 minutes of rest. After 5 minutes have elapsed I will ask you to sit for 15 minutes with your eyes closed. Please sit quietly without moving or talking and keep your hands on the arm rest with your palms facing upward. Do you have any questions? Okay then, starting with your eyes open just relax and I will tell you when 5 minutes are up.

6. Turn On EMG, GSR, Temperature, 3 Optical Isolators, Computer, and Printer.

7. Settings EMG scale X1; GSR scale X1; Temperature - center needle.

8. Identify subject on ticker tape.

Example:	Name:	John Headache
	Date:	May 30, 1981
	Therapist's Initials:	P.F.
	Initial Temperature Setting:	72

   During session draw lines to divide "A" - 5 minutes adaptation; "B" - 15 minutes relaxation; "C" - 3 minutes stress; "D" - 5 minutes recovery. Label periods between lines on the ticker tape.

9. Turn on Music low volume.

10. Start Timer and Computer Conduct 5 minute adaptation.

Reset temperature where necessary but only while printer is operating. Write in new value on the printout. Use a dashed line to mark where new value begins on printout.

After 5 minutes draw a line on the printout and mark "B" in next section.

Reset timer for 15 minutes.

11. Relaxation period Say to subject: "And now I would like you to sit for 15 minutes with your eyes closed. Try not to fall asleep."

After 15 minutes draw a line on the printout and mark "C" in the next section.

Reset timer for 3 minutes.

12. Stress period Say to the subject: "Okay while keeping your eyes closed now I want you to perform a mental task for me. I want you to subtract 7 from 1000 and then to continue subtracting 7 from your answer as fast as possible until I tell you to stop. Then I will ask you what number you got to. Do this in your head not out loud. Okay so 1000 minus 7 is ... now keep going, to yourself."

After 3 minutes say "Stop".

Draw a line on the printout and mark "D" in the next section.

Ask: "What number did you get to?"

Reset timer for 5 minutes.

13. Recovery Period Say to client: "Now I just want you to relax again with your eyes closed and listen to the music without interruption for 5 minutes and then we are finished.

After 5 minutes end session and disconnect subject.

Graph data and check batteries.

APPENDIX F

Headache Monitoring Form

PROGRESS CHART

It is important to monitor the intensity of your headaches for at least two reasons:

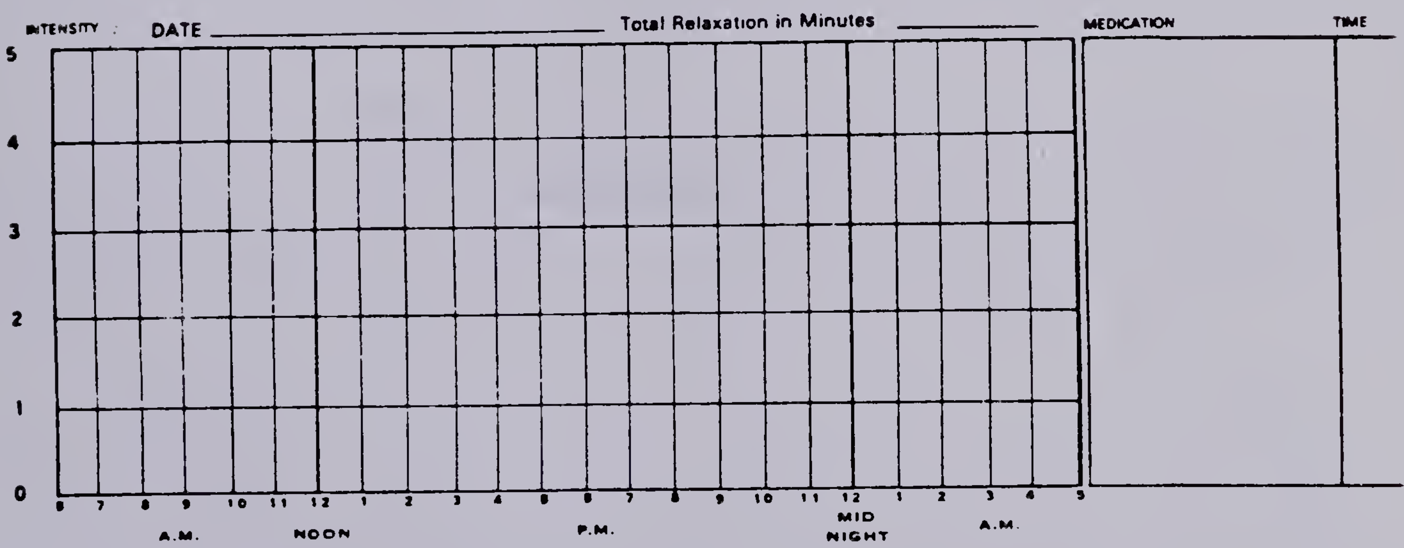
1. Research has shown that this will help to reduce the psychological side affects that often accompany a headache.
2. It is useful in helping to determine the affects of your treatment program.

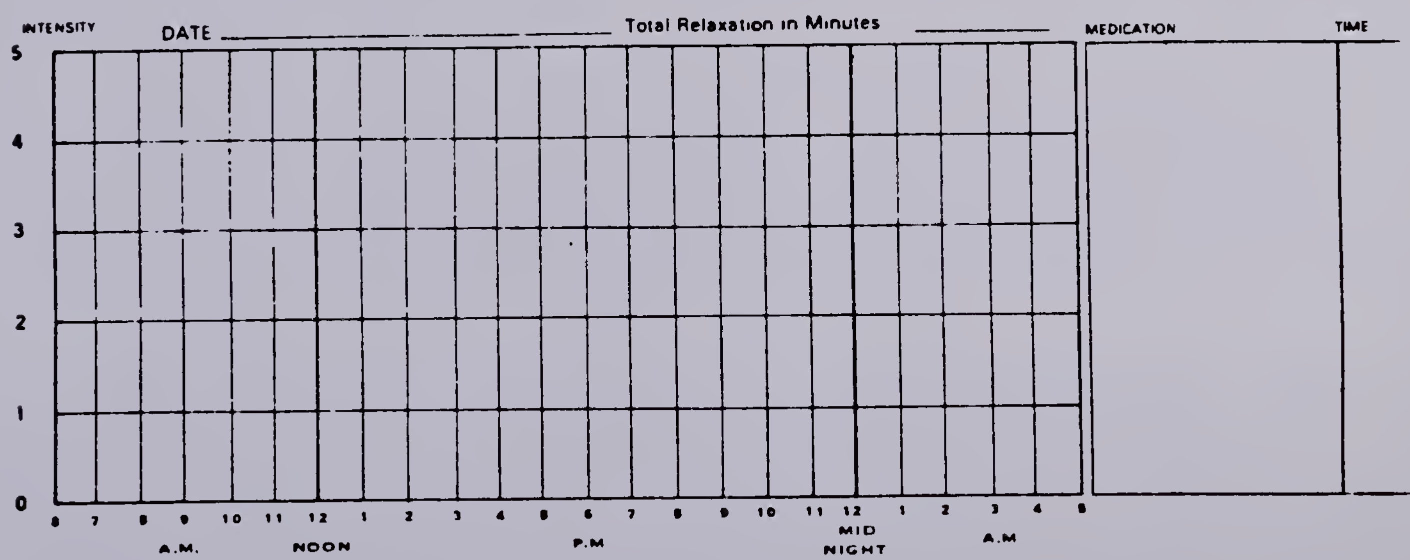
The following five point scale is useful in helping people monitor the severity of their headache.

0 — No headache.
1. — Low level, only enters awareness when you think about it.
2 — Aware of headache most of the time but it can be ignored at times.
3 — Painful headaches but still able to continue job.
4 — Severe headache, difficult to concentrate with undemanding tasks.
5 — Intense incapacitating headache.

To monitor your headache level mark the appropriate number on the graph at each hour and join the points together. Placing the coloured dot on your watch will help you remember to do this.

NAME: ____________________





APPENDIX G

EMG Training Rationale

The treatment sessions you are receiving are designed to teach you how to produce more effective physiological relaxation at will. Your final goal in treatment is to become able to discriminate excessive stress in your body and be able to remove such stress in order to prevent migraine headaches. Regular and consistent practice at removing excessive stress will eventually develop into a life-style habit. When this occurs your body will maintain a more relaxed level of arousal without conscious effort. It may take somewhere between a couple of weeks to several months to develop this automatic habit, depending upon the amount of relaxation practice you do and the strength of the stress habit you now have.

In biofeedback training you will learn to relax efficiently, guided by the feedback signal. The idea is to decrease your muscle tension voluntarily as you relax and learn to use decreased muscle tension as an index of your relaxation level. Over time you will learn to produce greater levels of relaxation in less time and to maintain these levels for longer periods. Even though the biofeedback is only attached to the head region it is to your advantage to learn to decrease your muscle tension as part of a total body relaxation response.

Biofeedback guided relaxation takes place in three stages. The first stage is called the "awareness" stage where your brain is merely made aware of how much feedback corresponds to how much muscle tension. Gradually the second stage emerges where in addition to becoming aware of tension levels you become able to control the tension and further reduce it. This second stage is known as the "control" stage.

Please note that the control stage takes time to emerge because you must learn the skill involved. Also note that contrary to most other intentional learning you do, learning to relax does not involve active striving. The more you strive the more tense you will become. Instead of actively striving to reduce muscle tension you must passively concentrate on the feedback signal and "allow" the tension to reduce. In other words, "let it happen".

The final stage of biofeedback guided relaxation, following awareness and control is the "weaning" stage. Weaning involves practice at producing the relaxation response in the absence of the biofeedback signal. Such practice will begin once you have learned the relaxation response. In this way you can learn an effective relaxation skill which is not dependent upon biofeedback.

Many persons have asked what thinking strategies they should be using to decrease muscle tension as they passively concentrate. Other than advising such persons to avoid unpleasant thoughts or stress-related rumination there is no particular strategy that everyone will find effective. Some people use mental images of relaxing settings such as laying on a warm beach, skiing down a mountain in slow motion, or watching a beautiful sunset. Others think suggestive phrases to them-

selves such as "I am becoming warm and relaxed". Others do not think about anything, they let their minds go blank. Most people find some particular strategy useful at first but as they learn to relax efficiently, letting go of tension becomes a skill they can utilize without any conscious strategy. Over the course of the training sessions, you should use whatever strategies you feel comfortable with to relax. But remember, the important thing is not to force any approach or to try too hard, because effort is the opposite of relaxation. Just let the approach you choose flow, just imagine it is already happening.

(see Reference Note 1)

APPENDIX H

Digit Temperature Training Rationale

The treatment sessions you are receiving are designed to teach you how to produce more effective physiological relaxation at will. Your final goal in treatment is to become able to descriminate excessive stress in your body and be able to remove such stress in order to prevent migraine headaches. Regular and consistent practice at removing excessive stress will eventually develop into a lifestyle habit. When this occurs your body will maintain a more relaxed level of arousal without conscious effort. It may take somewhere between a couple of weeks to several months to develop this automatic habit, depending upon the amount of relaxation practice you do and the strength of the stress habit you now have.

In biofeedback training you will learn to relax efficiently, guided by the feedback signal. The idea is to warm your hands voluntarily as you relax and learn how to use hand warming as an index of your relaxation level. Over time you will learn how to produce greater levels of relaxation in less time and to maintain these levels for longer periods. Even though the biofeedback is only attached to one of your fingers it is to your advantage to learn how to warm as part of a total body relaxation response.

Biofeedback guided relaxation takes place in three stages. The first stage is called the "awareness" stage where your brain is merely made aware of how temperature changes correspond to vascular changes brought about by stress and relaxation. Gradually the second stage emerges where in addition to becoming aware of stress levels you become able to control the stress and further reduce it. This second stage is known as the "control" stage.

Please note that the control stage takes time to emerge because you must learn the skill involved. Also note that contrary to most other intentional learning you do, learning to relax does not involve active striving. The more you strive the more tense you will become. Instead of actively striving to warm your hands you must passively concentrate on the feedback signal and "allow" the warming to occur. In other words, "Let it happen".

The final stage of biofeedback guided relaxation awareness and control is the "weaning" stage. Weaning involves practice at producing the relaxation response in the absence of the biofeedback signal. Such practice will begin once you have learned the relaxation response. In this way you can learn an effective relaxation skill which is not dependent upon biofeedback.

Many persons have asked what thinking strategies they should be using to induce hand warming as they passively concentrate. Other than advising such persons to avoid unpleasant thoughts or stress-related ruminations there is no particular strategy that everyone will find effective. Some people use mental images of relaxing settings such as lying on a warm beach, skiing down a mountain in slow

motion, or watching a beautiful sunset. Others think suggestive phrases to themselves such as "I am becoming warm and relaxed". Others do not think about anything, they let their minds go blank. Most people find some particular strategy useful at first but as they learn to relax efficiently, letting go of tension becomes a skill they can utilize without any conscious strategy. Over the course of the training sessions, you should use whatever strategies you feel comfortable with to relax. But remember, the important thing is not to force any approach or to try too hard, because effort is the opposite of relaxation. Just let the approach you choose flow, just imagine it is already happening.

(see Reference Note 1)

APPENDIX I

E.M.G. Training Procedures and Instructions

1. Check tape in printer.

2. Take room temperature.

3. Collect forms from client.

4. Mark treatment session number in progress in file and on printout.

5. (a) Attach EMG electrodes. Make sure impedence levels read less than 1 for each electrode with scale setting at X30. If not re-do cleansing of forehead with alcohol.

   (b) Attach temperature thermister to the palmer surface of the second phalange of the middle finger on the nondominant hand.

6. Check if client has read the rationale, if not, have them read it.

7. Settings: Center temp. needle and record setting on printout. Leave EMG at X1 setting. Explain EMG gauge setting and units of measurement to clients. Occlude all gauges from client's view and disengage auditory feedback.

8. Turn on: EMG, Temp., Optical Isolators, Computer and Printer. Turn fluorescent lights off.

9. Identify Client on ticker tape.

   Example:

Room temp:	72°
Name:	John Headache
Date:	May 30, 1980
Therapist's Initials:	P.J.C.
Initial Temp Setting:	82°
Session:	Rx #1

10. Give the following instructions: This session will last approximately 40 minutes. Please keep your eyes open during the entire session. The session will consist of 4 phases. You will not receive any biofeedback during the first three phases. The first phase is an adaptation phase. For the next 5 minutes please just sit in the chair with your eyes open.

11. Start timer and computer simultaneously.

12. After 5 minutes draw a line on the printout and say "For the next 2 minutes I will be collecting baseline data. Please continue to sit quietly without talking and keep your eyes open."

13. After 2 minutes draw a line on the printout and say "For the next 2 minutes I would like you to decrease your muscle tension."

14. After 2 minutes draw a line on the printout and say: "This is the training phase. You will have three periods of 5 minutes of practice and 1 minute of rest. Uncover the EMG gauge. Have client put on headphones and turn up the volume to the preferred setting. Say: As you decrease the muscle tension in your head region the clicks will slow down. For the next 5 minutes I would like you to practice decreasing your muscle tension."

15. Draw a line on the printout and begin timer.

16. After 5 minutes draw a line on the printout and say "Please stop practising now and just take a break." Discuss performance. After 1 minute draw a line on the printout and say: "Now please begin practising again for 5 minutes." Follow with one minute of rest.

17. Follow with 5 more minutes of practice.

    Note: The order of items 18 and 19 can be conducted interchangeably so when subjects are seen in pairs, one person may be given 18 while the other does 19.

18. Conduct Written Summaries Procedure. At the end of each session discontinue biofeedback monitoring and give each subject the following instructions: "Please spend 5 minutes writing down a description of the strategies which you employed to relax and also identify any feelings or sensations which appeared to be associated with slower clicking. A new summary will be written each session and taken home with you until the next session at which time we would like you to hand it in for our records. Go ahead now, I will tell you when 5 minutes have elapsed."

    After the 5 minute period give the following instructions: "For training to be effective in suppressing migraines you must practise relaxation daily utilizing the strategies you have written down. In this manner you will be attempting to duplicate outside the lab. the same feeling state associated with slow clicking biofeedback.

    You will be asked to use the strategy to aid your relaxation during the final part of the relaxation tape. You are also asked to use the strategy to help you relax whenever you experience the prodrome (aura) or feel that you will soon get a migraine and also anytime during the day that you feel you are stressed or overly tense. Please remember to monitor the total minutes of daily relaxation you practise on your headache monitoring forms.

19. <u>Discuss Progress During Session</u>. At the end of each training session show each subject the EMG levels they achieved and compare these to the two-minute EMG average value computed at the end of 15 minutes of relaxation during the pretreatment monitoring session. Point out that ideally they will be learning to become more relaxed, faster, and be able to maintain such relaxed levels longer.

20. <u>Discuss Medication</u>. After each treatment session discuss medication consumption with the subject. Subjects should be advised and repeatedly reminded to monitor their medication intake and to consult with their physicians about any changes required in their prescriptions. Inform subjects that increased relaxation may alter the effects of their medication, migraine or otherwise. This is especially true for subjects taking medication for hypertension, or diabetes.

(see Reference Note 1)

APPENDIX J

Temperature Training Procedure and Instruction

1. Check tape in printer.

2. Take room temperature.

3. Collect forms from client.

4. Mark the treatment session number in progress in the file and on the printout.

5. (a) Attach EMG electrodes. Make sure impedence levels read less than 1 for each electrode with scale setting at X30. If not re-do cleansing of forehead with alcohol.

   (b) Attach temperature thermister to the palmer surface of the second phalange of the middle finger on the non-dominant hand.

6. Check if client has read the rationale, if not, have them read it.

7. Ask client what they think their hand temperature is.

8. Settings: Center temp. needle and record setting on printout. Leave EMG at X1 setting. Explain temp. gauge setting and units of measurement to clients. Tell client what their hand temp. is. Occlude all gauges from client's view and disengage auditory feedback.

9. Turn on: EMG, Temp., Optical Isolators, Computer, and Printer. Turn fluorescent lights off.

10. Identify client on ticker tape.

    Example:

Room temp:	72°
Name:	John Headache
Date:	May 30, 1980
Therapist's Initials:	P.J.C.
Initial Temp. Setting:	82°
Session:	R_x#1

11. Give the following instructions: This session will last approximately 40 minutes. Please keep your eyes open during the entire session. The session will consist of 4 phases. You will not receive any feedback during the first 3 phases. The first phase is an adaptation phase. For the next 5 minutes please just sit in the chair with your eyes open.

12. Start timer and computer simultaneously.

13. After 5 minutes draw a line on the printout and say "For the next 2 minutes I will be collecting baseline data. Please continue to sit quietly without talking and keep your eyes open.

14. After 2 minutes draw a line on the printout and say "For the next 2 minutes I would like you to increase your temperature."

15. After 2 minutes draw a line and say: "This is the training phase. You will have three 5 minute trials of alternately practising warming and cooling your temperature 2°. Uncover the temperature gauge. Have the client put on the headphones and turn up the volume to the preferred setting. Say: "As you increase your temperature the tone will change. If you are at or above 90° please begin by cooling 2°. If you are below 90° please begin by warming 2°. Once you have warmed or cooled 2° please maintain that temperature for the remainder of the 5 minute period. Draw an arrow on the printout indicating whether the client is warming (⟶) or cooling (⟵). Use a block on top of the machine to show the client the direction the needle should go.

16. Draw a line on the printout and begin timer.

17. After 5 minutes draw a line on the printout and ask client to continue to warm if they have not reached 90° or reverse directions.

18. Continue the same procedure for one more 5 minute period.

    Note: The order of items 19 and 20 can be conducted interchangeably so when subjects are seen in pairs one person may be given 19 while the other does 20.

19. Conduct Written Summary Procedure. At the end of each biofeedback session, discontinue biofeedback monitoring and give subjects the following instructions: "Please spend 5 minutes writing down a description of the strategies which you employed to relax and also identify any feelings or sensations which appeared to be associated with hand warming. A new summary will be written each session and taken home with you until the next session at which time we would like you to hand it in for our records. Go ahead now, I will tell you when 5 minutes have elapsed."

    After the 5 minute period give the following instructions: "For training to be effective in suppressing migraines you must practise relaxation daily utilizing the strategies you have written down. In this manner you will be attempting to duplicate outside the lab the same feeling state associated with hand warming biofeedback in the lab.

You will be asked to use the strategy to aid your relaxation during the final part of the relaxation tape. You are also asked to use the strategy to help you relax whenever you experience the prodrome (aura) or feel that you will soon get a migraine and also anytime during the day that you feel you are stressed or overly tense. Please remember to monitor the total minutes of daily relaxation you practise on your headache monitoring forms.

20. Discuss Progress During Session. At the end of each training session show the subject the minute by minute temperature levels they achieved. If these levels at any time were higher than the temperature recorded after 15 minutes of relaxation during the profile session, then indicate this to the subject. Otherwise do not. Point out that ideally they will be learning to become more relaxed, faster, and be able to maintain such relaxed levels longer.

21. Discuss Medication. After each treatment session discuss medication consumption with the subject. Subjects should be advised and repeatedly reminded to monitor their medication intake and to consult with their physicians about any changes required in their prescriptions. Inform subjects that increased relaxation may alter the effects of their medication, migraine or otherwise. This is especially true for subjects taking medication for hypertension or diabetes.

(see Reference Note 1)

APPENDIX K

Biotic Band Monitoring and Recording

Please use your Biotic Band device to monitor finger temperature daily while you listen to the relaxation tape. Attach the band to the middle finger of your non-dominant hand. Place the band with the temperature scale on the palmer surface of your finger and center it mid-way along the length of your finger. The band should be snug but not tight. While relaxing try to sit in a comfortable chair with arm rests so that your hand temperature will not be effected by warmth from your lap.

As you practise relaxation note how your finger temperature increases. On your headache monitoring form, write down your finger temperature: (a) after the band has been on your finger for 1 minute and before you start the tape, and (b) at the end of the tape.

Please avoid crushing or crumpling the band as they may become inaccurate with abuse. If you think that your band has broken bring it in to your next training session. The bands <u>must</u> be returned at the end of treatment.

BIOTIC-BAND II has a range of 20.0 F divided into two degree intervals which are indicated on the band by the printed numbers. The liquid crystal squares beside the numbers light up when the temperature of the finger being monitored comes within that two degree range. Within each range of two degrees, color changes indicate smaller changes in the temperature. Each color change equals a change of 0.5 F as shown in the table below.

Lighted Degree	Red-Tan	Orange	Yellow-Green	Blue-Green	Blue
78	78	78.5	79	79.5	80
80	80	80.5	81	81.5	82
82	82	82.5	83	83.5	84
84	84	84.5	85	85.5	86
86	86	86.5	87	87.5	88
88	88	88.5	89	89.5	90
90	90	90.5	91	91.5	92
92	92	92.5	93	93.5	94
94	94	94.5	95	95.5	96
96	96	96.5	97	97.5	98

In taking a reading always read the highest temperature showing. The purple color which may sometimes be visible on some squares should always be ignored.